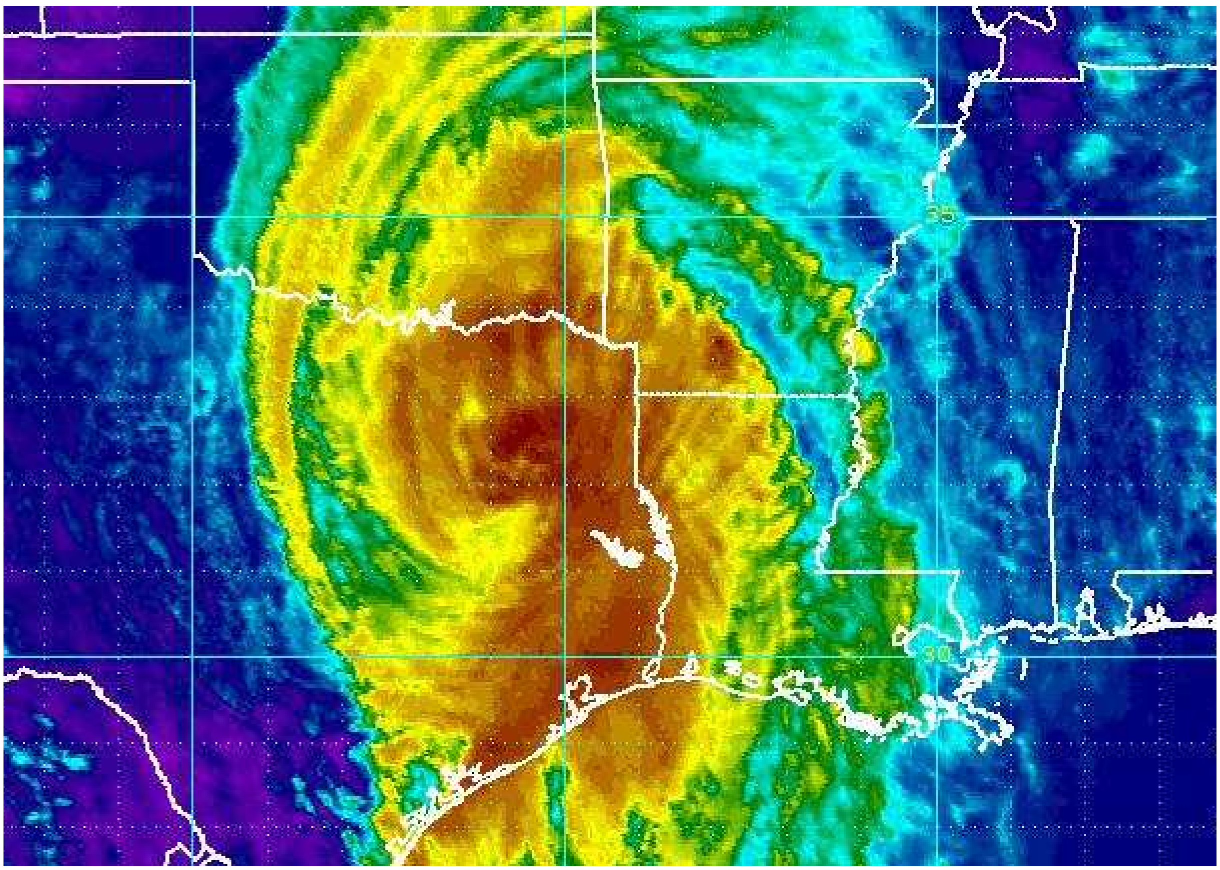
2008 Hurricane Ike

Wildland Fire Hazard Assessment



GOES-FLOATER RAINBOW IR CH. 4 SEPT. 13 08 1845 UTC

September 18, 2008

Assessment Period:
September 2008 – April 2009

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EXECUTIVE SUMMARY

Background

Hurricane Ike made U.S. landfall at Galveston, Texas, on September 13 at 2:10am CDT, as a Category 2 hurricane with winds of 110 mph and a central pressure of 952 mbar. The 2:00 am NHC advisory cited tropical storm and hurricane force winds extending 275 miles and 120 miles, respectively, from the center.

During the day of September 13, Ike began a slow turn to the north and then northeast. After losing strength to Tropical Storm force winds, it passed 100 miles to the east of Dallas, Texas; and west of Little Rock, Arkansas. It became a Tropical Depression and continued northeast, passing near St. Louis, Missouri. It brought heavy rainfall all along its path, but moved more quickly the farther north it went.

On September 14, after becoming extratropical and enhanced by an upper level shortwave trough, a major wind event took place across the lower and middle Ohio Valley, and significant rainfall and flooding took place to the west. Hurricane-force wind gusts were reported to the east of the center across parts of Kentucky, Indiana, Ohio and Pennsylvania with significant wind damage including structural damage to buildings and trees.

Damage

The damage due to Hurricane Ike was primarily in the pine forest and bottomland hardwood cover types on the east side of Texas. Managed and open pine stands farther inland received light damage in some areas. Related wind events caused damage as far north as the Ohio Valley. This assessment analyzed the change in potential fire behavior in the moderate and light severity damage levels limited to the east side of Texas; no areas of severe damage were mapped. Appendix B contains an assessment of wildland fire hazard for Land Between the Lakes National Recreation Area in Kentucky.

Changes in Fuel Characteristics

The changes in fuel characteristics after Hurricane Ike can be summarized by vegetation cover type:

Coastal Marshes
The fuel models for this cover type remain the same post-hurricane, but they are more prone to having significant building debris, and the herbaceous component is considered fully cured. Therefore, what was a live herbaceous load is transferred to dead herbaceous. New available fuels that are hazardous could also be within the fuel profile.

Pine Sandhill and Pine Forests
The primary change within these forests is a result of wind damage to the overstory trees. This damage occurred in the heavily thinned stands or where leave trees were left. This wind damage can create significant increases in fuel loadings and fuel bed depths. Where contiguous healthy stands were observed, no damage had occurred.

Pine Savannah Wetlands
The Longleaf Pine-Slash Pine vegetation types are prone to extensive blowdown under light and moderate damage levels because they grow fairly rapidly and don’t have the wood strength to resist wind damage. Therefore, an increase in wind damaged trees results in greater blowdown damage. Those areas most prone to blowdown were along stand edges or in recently harvested areas, and the stands managed for Red-cockaded woodpecker in the National Forests.

Bottomland Hardwood Swamp
The damage associated with high wind speeds in these vegetation types is primarily due to trees blowing over and increasing the amount of litter and large downed woody debris. Most of the damage within the hardwood stands is considered moderate severity.

Climate & Weather

Precipitation events affected the Hurricane Ike area of interest significantly over the last 30 days. Flooding rains during the last part of August and Hurricanes Gustav and Ike provided sufficient moisture to ameliorate the impacts of short term drought and reduce fire danger potential across east and southeast Texas with the possible exception of areas in the Western Pineywoods and Southeast Texas Predictive Service Areas. Fire danger levels currently stand at normal to below normal across the area.

The Climate Prediction Centers Long Lead Outlook indicates a higher probability of above normal temperatures throughout the area of interest through the fall over the winter and into the spring through April and equal chances of above, below or normal precipitation until March and then a higher probability of below normal precipitation beginning in April and May.

In looking at the short, medium and long range outlook for fire danger potential the most critical factor will be a higher probability of higher than normal temperatures over the "cured season". Above normal precipitation forecasted over the next 8-14 days on top of moisture surpluses gained over the last 30 days may be sufficient to provide a buffer against fire potential over the medium term (1-2 months).

Management Implications & Recommendations

Hurricane Ike damage assessments from the field indicate widespread moderate damage from the coast inland for up to 65 miles with the majority of moderate damage confined to the bottomland hardwoods and coastal marshes. Bottomland hardwoods have not historically contributed to wildfire risk except during periods of severe drought. Deposition of debris and effects of inundation with salt water will change the fire behavior and management tactics in the coastal marshes. Damage in the more inland pine stands will contribute to a significant increase in potential fire behavior in these areas.

The changes resulting from Hurricane Ike will require that we alter our wildland fire management response. More importantly, there is the safety concern to fire suppression personnel if we do not alter our management strategy.

Conclusion

The analysis of post-hurricane changes in fuel conditions found three general areas of concern. The coastal marshes will experience an increase in dead fuel load as salt water inundation causes greater mortality; in combination with deposition of debris from hurricane-damaged infrastructure, the nature and effects of fire in these areas may be altered and require different management strategies. The bottomland hardwood vegetation cover type has traditionally served as a barrier to wildfire growth except under severe drought conditions, but the potential for uncharacteristic fire behavior and effects as well as the firefighter safety aspects of changes in fire behavior in this vegetation cover type bears additional research and monitoring efforts. The managed and more open pine forest stands farther from the coast were subject to greater damage and subsequent greater increases in fuel loading than denser stands, and may see a greater increase in fireline intensity.

INTRODUCTION

Hurricanes & Wildland Fire Hazard Assessment

Both hurricanes and wildfires have historically been recurring disturbance events along the Gulf Coast of the southern United States, and the connection between hurricane events and increased wildfire hazard has been indicated by scientific study and recent experience in this geographic area (Myer & van Lear 1998; Cross et al 2005). The increase in wildfire hazard can be quantified in an analysis of the change in potential fire behavior between the pre-hurricane fuel conditions compared to the post-hurricane conditions of the fuels.

Background

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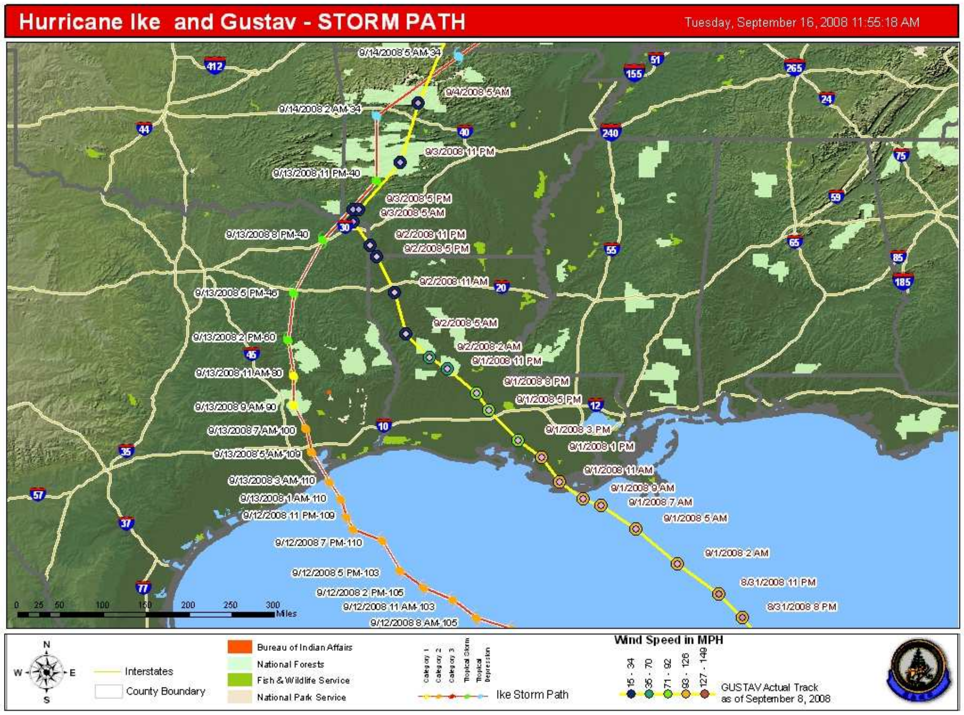
Hurricane Ike was the ninth named storm, and fifth hurricane of the 2008 Atlantic hurricane season. Less than two weeks earlier, Hurricane Gustav had made landfall as a strong Category 2 hurricane in Cocodrie, LA, approximately 265 miles east of Galveston. The area between these two 2008 hurricanes had been heavily impacted by Hurricane Rita in 2005. **Enlarged images of the maps on the following page and throughout this document are found in Appendix A.**


Hurricane Ike and Gustav - STORM PATH
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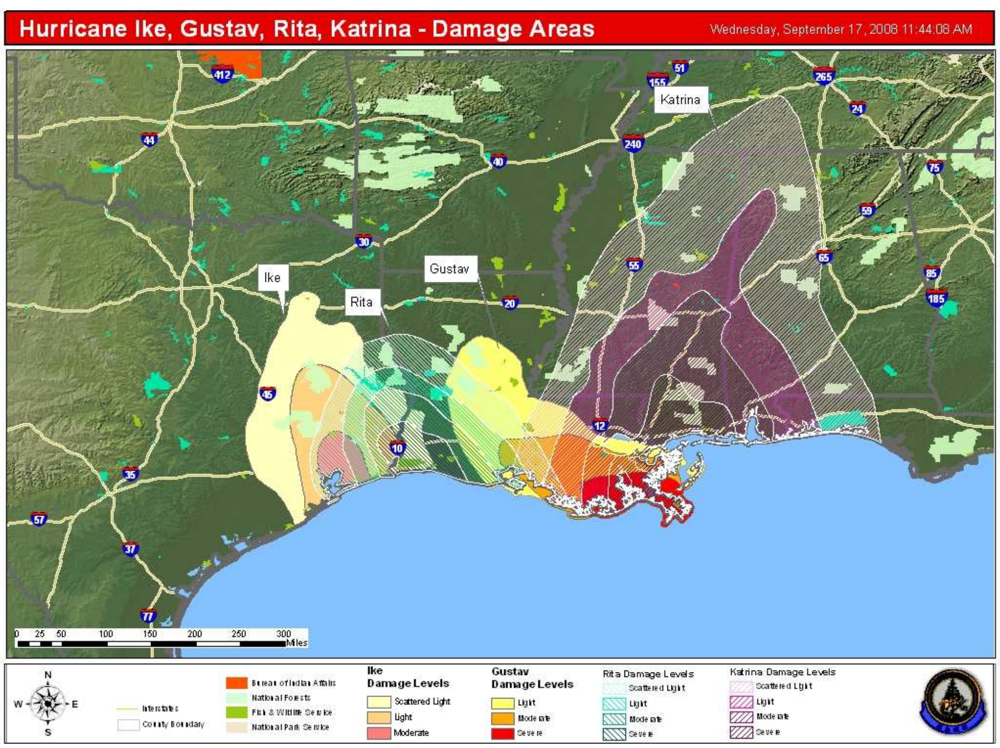
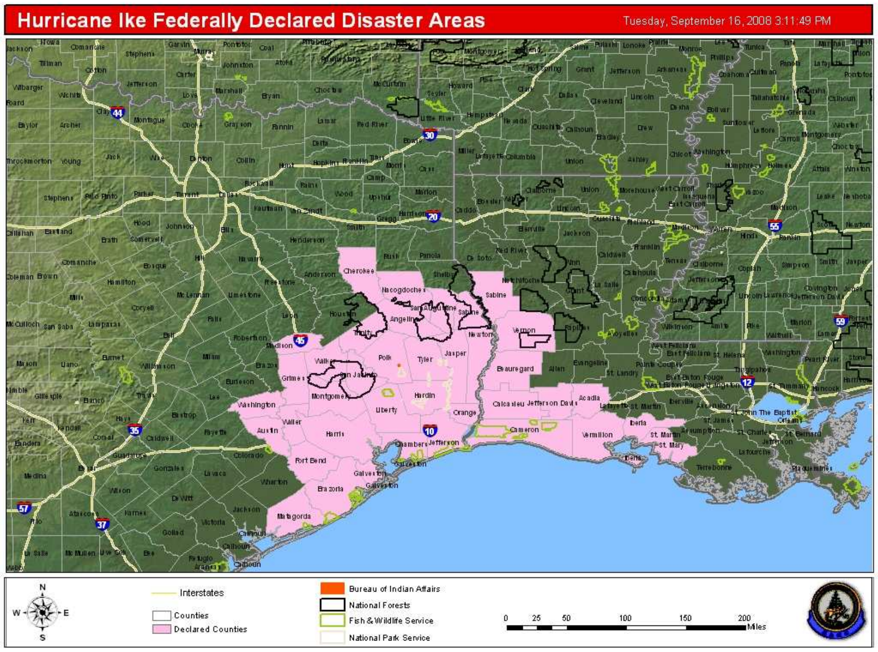
Interstates
County Boundary
Bureau of Indian Affairs
National Forests
Fish & Wildlife Service
National Park Service
Ike Storm Path
Wind Speed in MPH
15 - 34
35 - 70
71 - 92
93 - 126
127 - 149
GUSTAV Actual Track
as of September 8, 2008
Miles


Hurricane Ike, Gustav, Rita, Katrina - Damage Areas
Wednesday, September 17, 2008 11:44:08 AM
Katrina
Gustav
Ike
Rita
Miles
Ike
Damage Levels
Scattered Light
Light
Moderate
Gustav
Damage Levels
Light
Moderate
Severe
Rita Damage Levels
Scattered Light
Light
Moderate
Severe
Katrina Damage Levels
Scattered Light
Light
Moderate
Severe



Fire Use Management Team

The assessment was produced by the Northern Rockies Fire Use Management Team (FUMT) during the period of September 11-18, 2008 at the request of the USFS Region 8 Fire and Aviation Management Director (some data preparation was accomplished prior to the landfall of Hurricane Ike). Regional FAM staff and other specialists assigned to Hurricane support worked with the FUMT to generate the analyses and images. Members of the Assessment Team, their specific contributions and their contact information is provided in Appendix E.

The objectives for the assessment are to:

- Provide a seasonal weather analysis for the remainder of 2008 until the likely end-of-season event in spring of 2009 with potential scenarios and probabilities.
- Provide an assessment of pre-event versus post-event fuel changes that are predicted to substantially alter fire behavior and resistance to control.
- Create and document a process to spatially depict these changes and summarize their extent and severity.
- Create and document a process to prioritize general areas for treatment or other management actions based on increases in fire behavior, historical fire occurrence, and values at risk.
- Identify recommended changes to management actions in the prevention, preparedness, fuels, suppression and monitoring programs in response to post-event fuel conditions.
- Provide an assessment of potential safety issues related to post-event fuel conditions and associated safety recommendations.

HAZARD ASSESSMENT METHODOLOGY

The methodology for this hazard assessment evolved from incorporating the recommendations from the 2008 Hurricane Gustav Wildland Fire Hazard Assessment into the assessment process for Hurricane Ike. The primary difference is in the use of spatial data to analyze changes in predicted fire behavior due to the effects of the hurricane. As part of this spatially explicit process, LANDFIRE data was incorporated to provide base vegetation and fuel model data layers, and FlamMap (Finney 2006) was used to analyze the potential fire behavior. The analysis focuses on fireline intensity and flame lengths as they relate to resistance to control. Spatially explicit changes in resistance to control are related back to the Fire Characteristics Chart, a familiar reference point for fire managers and firefighters throughout the country.

Assumptions & Limitations

All models and assessments must make assumptions to simplify the data and reduce the complexity of the calculations and results to manageable levels. These assumptions result in limitations of the models and assessments that are important for users of the assessment to be aware of and understand to prevent the results from being applied outside the arena for which they are valid and supportable.

- "Scattered light" damage levels did not result in a change in fuel model or a significant change in fire behavior.
- All lands within the assessment area boundary can be classified into 5 vegetation cover types. The LANDFIRE Existing Vegetation Types (EVT) can be represented by one surface fire behavior fuel model.
- Post hurricane vegetation can be classified by Existing Vegetation Type and one representative fuel model based on damage level.
- Dennis Jacob's damage level model based on rainfall and windspeeds, adjusted by aerial survey with Texas Forest Service, will be the basis for estimated hurricane damage to vegetation. Spatial data as far as exact damage locations is not available for this assessment.
- Damage possibly occurred outside of these estimated damage levels. Damage estimates only apply to vegetation. Damage to buildings or other infrastructure is not part of this assessment.
- Fire behavior modeling was for surface fire only; crown fire modeling was not used or attempted.
- LANDFIRE was the source of data for existing vegetation, slope, aspect, elevation, and fuel model (Scott and Burgan 40).
- Fire behavior modeling was representative of percentile weather from the Lufkin remote automated weather station for the period of analysis.
- Fire behavior models for moderate and light damage areas were altered post hurricane by local knowledge and photos received from the field. These fuel models were not ground truthed by the assessment team.
- Forecasted weather beyond 7 days is based on models and trends.

PRE-HURRICANE VEGETATION & FUEL CONDITIONS

There are a several vegetation communities that were damaged during Hurricane Ike. For this analysis, the vegetation cover types from the 2008 Hurricane Gustav Wildland Fire Risk Assessment were used to group those vegetation communities. The primary reason to continue utilizing these descriptions is to maintain the consistency with the previous analysis and provide a common base of understanding amongst the potential different users of the document. The 40 Standard Fire Behavior Fuel Models and the Existing Vegetation Types from the LANDFIRE fire behavior and vegetation data products (2008) were used to further describe each of the vegetation cover types. An introduction to the Standard Fire Behavior Fuel Models (the "40 fuel models") as used in this assessment is found in Appendix C.

Coastal Marshes

Freshwater marshes are non-forested, non-tidal wetlands dominated by grasses, sedges, and other freshwater emergent plants. Freshwater marshes are highly productive ecosystems and can sustain a wide variety of plant communities. In addition, the flat nature of most marshes helps to mitigate flood damage and filter excess nutrients from surface runoff. The Saline and brackish marshes that occur along the Gulf Coast of Texas and Louisiana are complex and highly productive ecosystems that contain a variety of plant and animal species. These plants and animals are specially adapted to fluctuations in salinity, water levels, and seasonal temperatures.

Fire management in both fresh and salt water marshes consists of burning during the fall and winter every 1 to 5 years to prevent invasion of woody species and promote the growth of spartina and other marsh grasses (Nyman and Chabreck, 1995). It is preferable to burn during the fall and winter when wildlife is not nesting. Wildfires during periods of drought or before flooding can damage plant roots that are unable to recover if they are subsequently submerged for any length of time (Nyman and Chabreck, 1995). Hurricane and other tropical storm activity can play a role in maintaining plant species diversity within a marsh system, but can also contribute to coastal erosion and inland sedimentation. Saltwater intrusion from severe storms can "burn" freshwater vegetation causing marsh grasses and sedges to be killed.

The fuel conditions are best represented by the standard grass fire behavior fuel models. The grass and herbaceous fuel load is relatively light with a fuel bed depth of 1.5 to 2 feet. Shrubs are generally not present or do not significantly affect fire behavior. The Low load, Very Course, Humid Climate Grass (Dynamic Fuel Model GR3) corresponds to Gulf Coast Salt Marsh and Sea Oats EVT, and the Low Load, Humid Climate Grass (Dynamic GR5) corresponds to Florida Salt Marsh EVT.

Prairies

The coastal prairies of Texas and Louisiana stretch along the gulf coast for approximately 400 miles. They are characterized by tall grasses such as little bluestem, cane bluestem, tall dropseed, and a variety of midgrasses (handbook of Texas online). Whereas factors such as soil type and rainfall contribute to the formation of prairies, fire is the natural mechanism by which the prairie renews itself. Fire prevents woody plants from establishing, stimulates seed germination, replenishes nutrients, and allows light to reach young leaves. Historically, coastal prairie fires occurred in the summer as a result of lightning strikes. Fires, along with drought and competition from herbaceous plants, prevented the establishment of woody plants to maintain a grass-dominated ecosystem.

Fire management in this habitat type typically takes place in the winter and spring on a 2-3 three year rotation. Fire behavior is characterized by rapid rates of spread that top kills woody species and removes the cured grasses.

The fuel conditions associated with this standard grass fuel model are similar to the Coastal Marshes. The grass and herbaceous fuel load is relatively light with a fuel bed depth of 1.5 feet. Shrubs are generally not present or do not significantly affect fire behavior. The Low load, Very Course, Humid Climate Grass (Dynamic Fuel Model GR3) corresponds to the Modified/Managed Grassland, Bluestem Prairie, Mesquite-Live Oak-Seacoast Bluestem, Mesquite-Ganjeno-Acacia, Bluestem-Sacahuista Prairie and Little Bluestem-Indiangrass-Texas Wintergrass EVT.

Western Coastal Plain (East Texas/Western Louisiana Piney Woods)

Vegetation of the western Coastal Plain is best characterized by two types of pine-dominated forests: 1) well-drained sandhill and pine forests and 2) pine savannah wetlands that are wet for part or most of the year.

1) *Pine Sandhill and Pine Forests*

Pine Sandhill and Pine Forests are found on well-drained sandy soils with a mixture of loblolly, longleaf and shortleaf pines. The Pine Sandhill forest consists primarily of a sparse herbaceous understory, patches of bare sand and a shrub component dominated by bluejack and post oaks. Pine Forests can have a dense understory of post oak, sumac, sassafras and wax myrtle with a herbaceous layer of forbs and grasses such as bluestem.

These well-drained forests are characterized by a frequent, low to moderate intensity fire regime. Prescribed burning is typically conducted on a 3-5 year rotation to maintain the sites. The poorly developed soil profile keeps duff depths to a minimum and the lack of available large fuel results in an intense fire of short duration. Little or no mop-up is usually required. Burning conducted during dormancy will maintain a low density rough.

The forest fuel conditions are variable depending on the understory vegetation and surface fuel profile. Therefore, several standard fuel models ranging from grass, shrub and timber litter types are used to describe the following existing vegetation types. The Post Oak-Blackjack Oak EVT is a common component in the Pine Forest types, and is represented by the Low Load, Broadleaf Litter (Fuel Model TL2) and the Moderate Load, Broadleaf Litter (Fuel Model TL6). The Shortleaf Pine-Oak EVT has a large amount of woody shrubs, shrub litter, and some herbaceous in the understory. The variation and dynamics associated with this vegetation type is best represented by the Very High Load, Humid Climate Shrub (Dynamic Fuel Model SH9).

The Longleaf Pine-Scrub Oak EVT and the Longleaf Pine-Hardwood EVT have either grass or broadleaf litter as the surface fuel component. The fuel conditions for this type are represented by Low load, Very Course, Humid Climate Grass (Dynamic Fuel Model GR3) and the Moderate Load, Broadleaf Litter (Fuel Model TL6).

The Live Oak EVT is an evergreen or near evergreen tree that drops its leaves and re-grows new ones. The fuel conditions for this type are represented by the Moderate Load, Broadleaf Litter (Fuel Model TL6). The Ruderal Forest EVT is within those areas where ground disturbance has occurred. These forests are defined by a relatively low fuel bed depth and low-moderate fuel loading with compact leaf litter. The Low Load, Broadleaf Litter (Fuel Model TL2) and the Moderate Load, Broadleaf Litter (Fuel Model TL6) are representative of the fuel conditions for these sites.

The Recently Logged Timberland Shrub EVT is represented by Moderate Load, Humid Climate Grass-Shrub (Dynamic Fuel Model GS). Lastly, the Managed Tree Plantation or Recently Logged Timberland-Herbaceous EVT(S) are common throughout East Texas and Western Louisiana. As a result, there are numerous pine plantations that have grass in the understory. The fuel conditions are best defined by the Low load, Very Course, Humid Climate Grass (Dynamic Fuel Model GR3).

2) *Pine Savannah Wetlands*

Wetter pinelands occur in areas of poor drainage. These Pine Savannah Wetlands contain scattered longleaf pine with some blackgum and sweetgum in the wettest areas. The mid-story of these forests is the most noteworthy aspect in relation to fire management as shrubs consist of highly volatile sweetbay, wax myrtle, titi and gallberry. This forest type typically burns only under extreme conditions, but receptivity to fire can be exacerbated by needle-drape from the pine overstory. When fires do occur, smoldering ground fire can consume massive amounts of fuel and cause long-term problems with smoke production. Once the soil layer is exposed root structures can weaken, toppling or killing overstory trees.

The standard fuel models are classified as grass or timber litter depending on the amount fine fuels (grass/litter component). The Moderate Load, Humid Climate Timber-Grass-shrub (Dynamic

Fuel Model TU3) and the Moderate Load, Broadleaf Litter (Fuel Model TL6) corresponds to the Longleaf Pine-Slash Pine EVT

Bottomland Hardwood Swamp

Bottomland hardwood swamps are found throughout the southeast US in all river basins, but predominate along the Gulf Coast in Louisiana south of Baton Rouge and Layfayette to the marshes of the Mississippi River delta. The swamps are characterized as forested, alluvial swamps growing on intermittently exposed soils most commonly along rivers and streams but also occur in backswamp depressions and swales. The soils are inundated by surface or ground water year round, but can dry completely during periods of extreme drought (www.wlf.louisiana.gov/*).* The swamps are comprised of a dense tall forest of broadleaf and needleleaf deciduous trees and evergreen shrubs. Cypress and Tupelo Gum dominate the overstory with Red Maple, Black Gum and Virginia willow residing in the mid and understory.

Climatic climax communities rarely occur in southern floodplain forests because of the dynamic nature of the ecosystem. Species composition in southern floodplain forests is a function of constantly shifting factors like stream migration, soil erosion, and deposition, which change the substrate. Plant species differ in their tolerance of flooding and shade and in their colonizing abilities (Fire Effects Information System, Southern Floodplain Forest http://www.fs.fed.us/database/feis).

Since fire is an infrequent visitor to hardwood bottomland forests organic material builds up over time as deciduous trees (Cypress and Tupelo) drop their needles and leaves in the winter. These swamp forests are typically inundated anywhere from 6-12 months a year. During times of extreme drought, swamp forests can completely dry out through the organic layer. It is during these periods of extreme drought when fire from adjacent uplands can become a concern. Slow-burning peat fires, which can ignite when moisture levels go below 30 percent, kill cypress roots and prevent them from sprouting. These peat or muck fires produce large quantities of smoke and are only extinguishable through inundation by flooding. It appears that after long drought periods fires will do greater damage in the center of swamps where the organic layer is thicker. Here tree roots are imbedded in peat and, therefore, not protected from fire by mineral soil (Fire Effects Information System, Southern Floodplain Forest at http://www.fs.fed.us/database/feis). In situations where only the top litter layer is dry and the underlying organics retain moisture, surface fire can spread through the Cypress needle cast without damaging the Cypress, where the thin bark of the water and black tupelo offer little protection against fire.

The vegetation types and fuel conditions for these areas are defined as Great Plains Riparian, Coastal Plain Swamp EVT, Willow Oak-Water Oak- Diamondleaf-Oak EVT, and the Introduced Woody Wetlands and Riparian Vegetation EVT is defined by the relatively low fuel bed depth and low fuel loading with compact leaf litter. The Low Load, Broadleaf Litter (Fuel Model TL2) is representative of the fuel conditions.

LANDFIRE Vegetation/Fuels Crosswalk

The Existing Vegetation Type and Standard Fire Behavior Fuel Models from the LANDFIRE data bases were used to describe fuel conditions and fire behavior characteristics that correlate to the 5 Vegetation Cover Types. Specifically, the EVT layer represents the vegetation currently present at a given site. Attribute information is provided that links the LANDFIRE EVT map units to existing classifications such as the National Vegetation Classification System and those of the Society of American Foresters and Society of Range Management. (LANDFIRE)

The Standard Fire Behavior Fuel Models: A comprehensive Set for Use with Rothermel's Surface Fire Spread Model (Scott and Burgan, 2005) was used to represent the complexity and dynamics associated with existing vegetation types. Specifically, the dynamics associated with live fuel moisture are better addressed using the grass fuel models from this publication as well as those areas where blow down occurred in the forested vegetation types. Those fuels that are dynamic, means that their herbaceous load can shift from live to dead depending upon the live herbaceous moisture content. The other fuel model parameters are consistent with the original 13 fire behavior fuel models such as dead fuel extinction moisture, which defines the moisture content of the dead fuels at which the fire will no longer spread. A description for the standard fire behavior fuel models used in this analysis is located in Appendix C. A Summary of Vegetation Cover Types Crosswalk to LANDFIRE EVT's and Standard Fire Behavior Fuel Models appears on the next page.

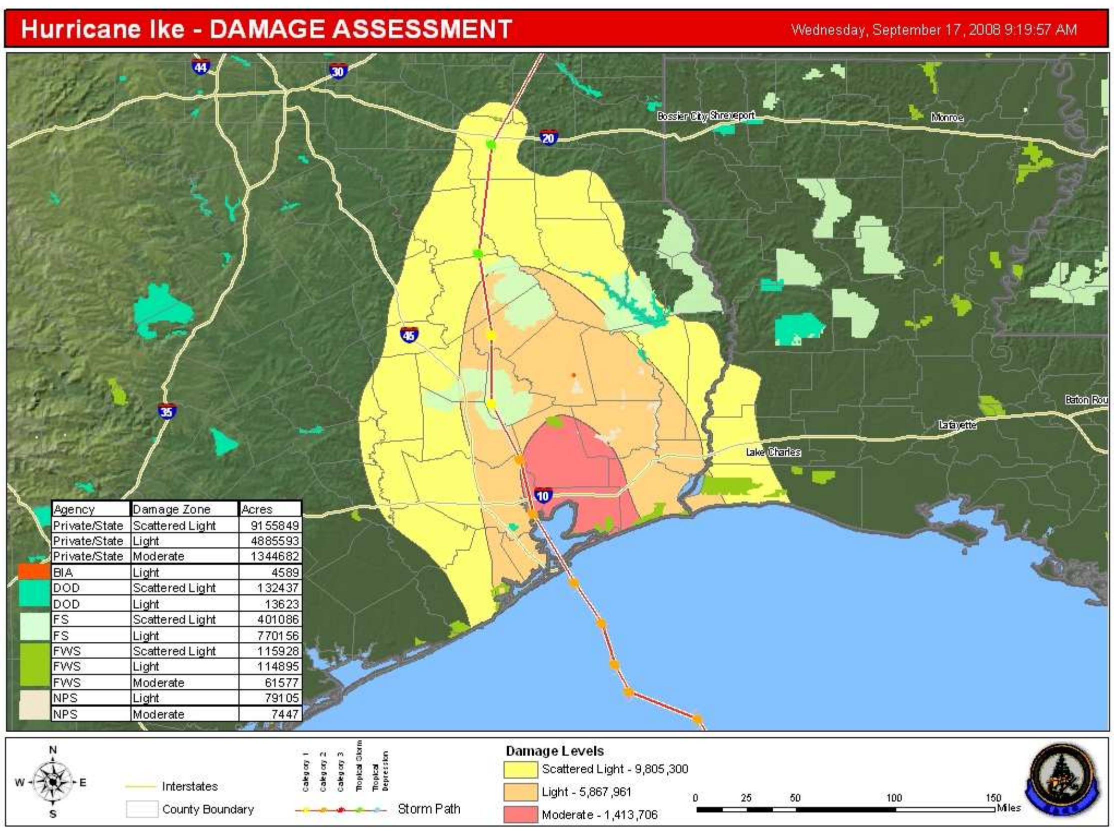
Summary of Vegetation Cover Types Crosswalk to LANDFIRE EVT's and Standard Fire Behavior Fuel Models

Vegetation Cover Types	LANDFIRE SAF_SRM Existing Vegetation Types	Pre-Fuel Model
Coastal Marsh		
	SRM 723 Sea Oats	GR3
	SRM 806 Gulf Coast Salt Marsh	GR3
	SRM 818 Florida Salt Marsh	GR5
Prairie		
	LF 69 Modified/Managed Grassland	GR3
	SRM 601Bluestem Prairie	GR3
	SRM 711Bluestem-Sacahuista Prairie	GR3
	SRM 717 Little Bluestem-Indiangrass-Texas Wintergrass	GR3
	SRM 719 Mesquite-Live Oak-Seacoast Bluestem	GR3
	SRM 728 Mesquite-Ganjeno-Acacia	GR3
WCP Pine Sandhill		
	LF 53 Ruderal Forest	TL2
		TL6
	LF 61 Managed Tree Plantation	GR3
	LF 62 Recently Logged Timberland-Herbaceous	GR3
	LF 63 Recently Logged Timberland-Shrub	GS3
	SAF 40 Post Oak-Blackjack Oak	TL2
		TL6
	SAF 71 Longleaf Pine-Scrub Oak	GR3
		TL6
	SAF 76 Shortleaf Pine-Oak	SH9
	SAF 82 Loblolly Pine-Hardwood	TL6
		GR3
	SAF 89 Live Oak	TL6
	SRM 732 Cross Timbers-Texas-Little Bluestem-Post Oak	N/A
WCP Pine Savannah Wetland		
	SAF83 Longleaf Pine-Slash Pine	TU3
		TL6
BLH		
	LF 42 Great Plains Riparian	TL2
	LF 46 Coastal Plain Swamp	TL2
	LF 58 Introduced Woody Wetlands and Riparian Vegetation	TL2
	SAF 88 Willow Oak-Water Oak-Diamondleaf Oak	TL2
	SAF 92 Sweetgum-Willow Oak	TL2
Other		
	LF 11 Water	N/A
	LF 20 Developed	N/A
	LF 31 Barren	N/A
	LF 33 Sparsely Vegetated	N/A
	LF 80 Agriculture	N/A

Western Coastal Plain = WCP
Bottom Land Hardwood = BLH
GR3&GR5*- Live Fuels considered fully cured, prone to heavy building debris

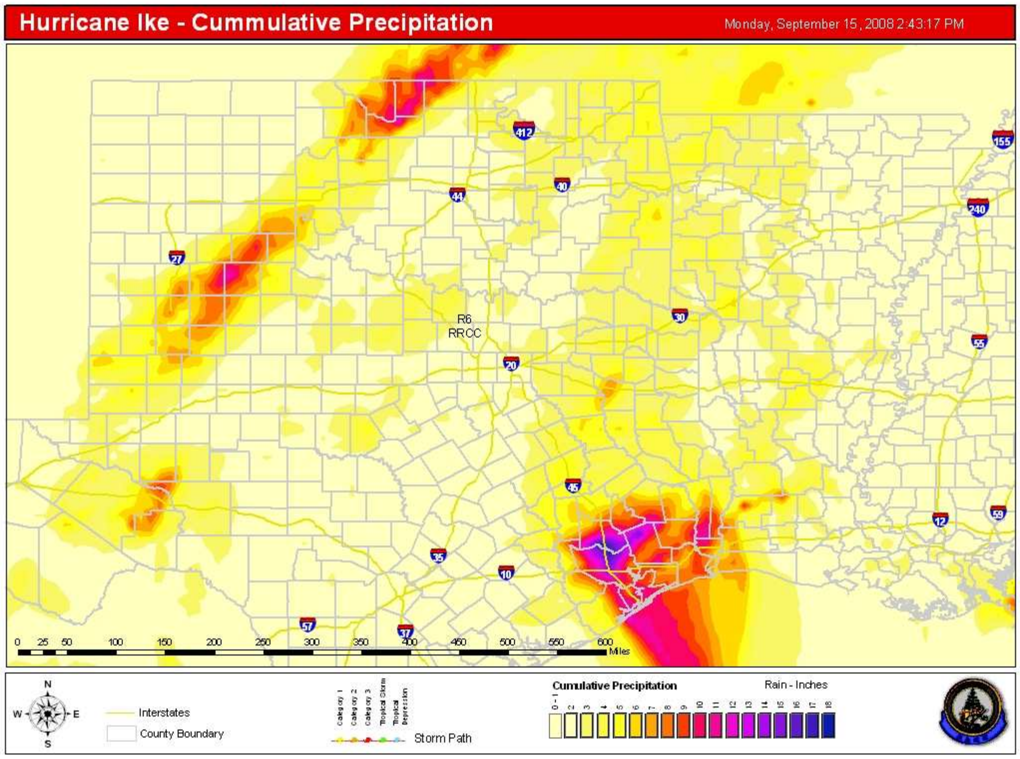
DAMAGE ASSESSMENT

Determination of hurricane damage to vegetation was completed on a very general scale due to the time constraints and lack of remotely sensed post hurricane data. Damage levels were estimated based on the Rapid Damage Assessment Model created by Dennis Jacobs (USFS, Forest Inventory & Analysis, Region 8) based on windspeed maps and rainfall patterns following landfall of Hurricane Ike. These windspeed maps and rainfall patterns were compared with visual observations on the ground, looking at current damage. Observation included comparing these same windspeed/rainfall patterns with damage found on past hurricanes. Based on these past and current observations, three damage categories were determined by the Rapid Assessment Model; the adjective ratings for these three categories are scattered light, light, and moderate (below). No areas of severe damage were mapped for the assessment area. **Larger versions of these images are located in Appendix A.**



Agency	Damage Zone	Acres
Private/State	Scattered Light	9155849
Private/State	Light	4885593
Private/State	Moderate	1344682
BIA	Light	4589
DOD	Scattered Light	132437
DOD	Light	13623
FS	Scattered Light	401086
FS	Light	770156
FWS	Scattered Light	115928
FWS	Light	114895
FWS	Moderate	61577
NPS	Light	79105
NPS	Moderate	7447

The following wind speed charts, along with rainfall patterns were used to evaluate the impact of the hurricane on vegetation. This is a very rudimentary analyses used to identify areas that will require on-site evaluation to determine actual fuel loadings and mitigation measures. The purpose here is to make an estimate of the number of acres impacted and to what degree the area has been damaged. The methodology for this analysis has been used on several assessments such as the 2004 Hurricanes and the 2005 Hurricane Katrina and Rita Wildland Fire Risk Assessments (Dennis Jacobs, personal communication).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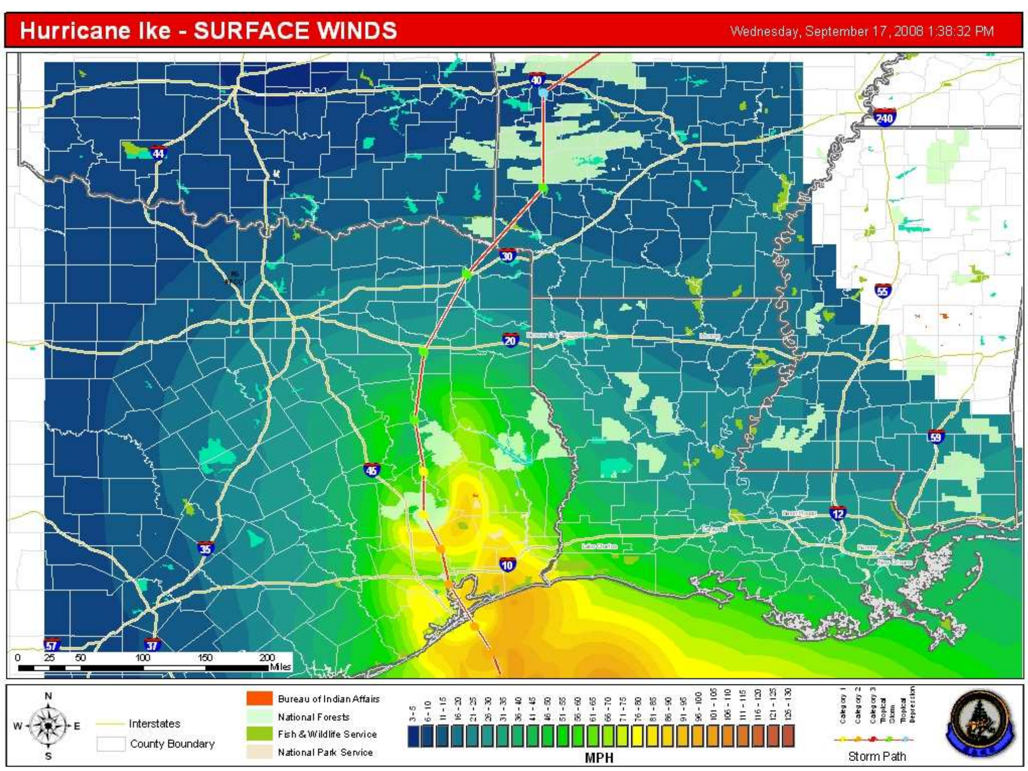
R6
RRCC
Interstates
County Boundary
Storm Path
Cumulative Precipitation
Rain - Inches
Miles


Hurricane Ike - SURFACE WINDS
Wednesday, September 17, 2008 1:38:32 PM
Interstates
County Boundary
Bureau of Indian Affairs
National Forests
Fish & Wildlife Service
National Park Service
MPH
Storm Path
Miles

Reports from the field and over-flights indicate pockets of damage within the damage area levels estimated. The Texas Forest Service (TFS) conducted an aerial survey on September 16, 2008. The flight plan was based on the preliminary damage map produced by the Southern Research Station. TFS used this flight to survey damage and generate a refined map of the damage levels. The refined map from TFS was used for this assessment. In particular, hardwood stands, heavily thinned stands, and stands managed for Red-Cockaded Woodpecker seemed to have the most damage. Early field verification and the TFS flight confirm that within each damage category, rather than viewing the entire area as damaged it is more likely that the damage is in isolated pockets. For example, it is not expected that the entire area shown as moderate damage area actually has moderate damage, rather moderate damage has occurred over that area in isolated pockets. The actual extent of the damage is unknown and verification of this will not occur for several weeks as more field data and imagery become available. It is also likely that some damage has occurred outside the damage levels indicated on the map. This may be due to spin offs of the hurricane or tornado activity that may not have been accurately detected or included in the damage level mapping estimates. Other than actual damage from winds on vegetation, in some areas damage from saltwater inundation of vegetation may have occurred. This can result in mortality of some species of plants that are intolerant of saltwater.

Scattered Light damage level – The scattered light damage level is the most predominate across the effected area. It is characterized by tropical storm forced winds (39 to 74 mph) and moderately heavy rain. Vegetation in this damage level is the least impacted. Damage can be described as small limbs on the ground, the occasional tree blown over, and generally the same impact that would be associated with thunderstorm activity. No significant change to the fuel loading has occurred as a result of the hurricane. Fire behavior and potential will be the same as pre - hurricane levels. Fuel bed depth, particularly in hardwood and pine stands will increase slightly. The canopy is generally still in place.

Light damage level - The light damage level is described as low Category 1 Hurricane winds (generally less than 85 mph) and slightly moderate to heavy rains. Damage could be described as mainly small to large size tree limbs, downed trees, and an increase in litter on the ground. The canopy is slightly broken. In general, some type of disturbance could be expected over approximately 15% of the trees or area.

Moderate damage level - The moderate damage level is determined by winds above 85 mph up to 111 mph (includes a high Category 1 and all wind speeds of a Category 2). Heavy rains are found in these areas. Damage can be described as numerous small, medium and large diameter limbs on the ground. A significant amount of trees are on the ground and tops broken out. The canopy of the forest is fragmented. In general, some type of disturbance could be expected over approximately 45% of the trees or area.

Severe damage level - The severe damage area is characterized by hurricane winds in excess of 111 mph, very large rainfall amounts and areas of wide spread destruction of forest stands. In this area, around 25% to 40% of the trees have been laid on the ground by the storms or all the tops have been broken. The forests could be considered “jack-strawed.” In general, some type of disturbance could be expected over approximately 60% of the trees or area.

Acres Contained Within Estimated Damage Levels on Federal Lands

Agency	Name	Scattered Light	Light	Moderate	Total
BIA	Alabama-Coushatta Indian Reservation		4,589		4,589
DOD	Steinhagen Lake	3,392	7,248		10,640
DOD	Ellington Air Force Base		6,375		6,375
DOD	Sam Rayburn Reservoir	129,045			129,045
FS	Davy Crockett National Forest	37,953	349,477		387,430
FS	Big Slough Wilderness	1,854	3,633		5,487
FS	Angelina National Forest	250,105	17,221		267,326
FS	Upland Island Wilderness	9,929	754		10,683
FS	Sam Houston National Forest	96,411	399,071		495,482
FS	Sabine National Forest	510			510
FS	Turkey Hill Wilderness	326			326
FS	Little Lake Creek Wilderness	3,998			3,998
FWS	Trinity River National Wildlife Refuge		2,054	19,352	21,406
FWS	McFaddin National Wildlife Refuge		33,798	10,427	44,225
FWS	Anahuac National Wildlife Refuge			29,509	29,509
FWS	Moody National Wildlife Refuge			2,289	2,289
FWS	Sabine National Wildlife Refuge	102,298	39,035		141,333
FWS	Texas Point National Wildlife Refuge		10,071		10,071
FWS	Brazoria National Wildlife Refuge	9,327	29,937		39,264
FWS	Little Sandy National Wildlife Refuge	3,574			3,574
FWS	San Bernard National Wildlife Refuge	729			729
NPS	Big Thicket National Preserve		79,105	7,447	86,552

Summary Acres Contained Within Estimated Damage Levels by Ownership

Ownership	Acres by Damage Level			Total Acres
	Scattered Light	Light	Moderate	
State / Private	9,155,849	4,885,593	1,344,682	15,386,124
Department of Defense	132,437	13,623		146,060
National Forest FS	401,086	770,156		1,171,242
National Wildlife Refuge FWS	115,928	114,895	61,577	292,400
National Park Service		79,105	7,447	86,552
Bureau of Indian Affairs		4,589		4,589
TOTAL ACRES	9,805,300	5,867,961	1,413,706	17,086,967

Damage Assessment Summary

Although detailed spatial post Hurricane Ike information is not readily available, the damage level assessment model provides an indication of where damage is likely to have occurred and how severe it may be. In general, much of the most severe damage that is expected to exist occurred near the Gulf Coast where windspeeds were highest. The vegetation in this area is variable but tends to have more of the coastal marshes and bays/bottomlands than pine forests. Using this damage level assessment process may not provide detailed spatial data, but it does give managers a starting point to begin surveys of damage. As more advanced techniques become available for assessing damage, assessments can include more detail and finer scale damage predictions.

POST-HURRICANE FUEL CONDITIONS

The post hurricane fuel conditions were developed by cross walking the Vegetation Cover Types, LANDFIRE Existing Vegetation Types, and the Post Hurricane Light and Moderate Damage Levels to determine the standard fire behavior fuel models that best represents the fire behavior and vegetation characteristics. In the grass and some of the shrub fuel models there may be little or no change in fuel model inputs. However in timber or hardwood vegetation types where trees have blown over, there will be a significant change in the fuel conditions.

Damage Levels

Scattered Light	Not analyzed for this assessment because no significant change in fuel loading from what existed prior to the hurricane in all of the vegetation types. Fuel bed depth, particularly in hardwood and pine stands may increase slightly. The canopy is still in place.
Light	A slight increase in surface fuel load and fuel bed depth will occur in the forested vegetation types. The canopy of the forest may be fragmented. Fuels are arranged more horizontally than vertically.
Moderate	In this area, around 25% to 40% of timber has been laid on the ground by the storms or all the tops have been broken. There is very little live fuel left in the fuel bed for the short term. In the forested areas, the 1hr, 10hr, 100hr, and 1000hr fuel loadings have all increased considerably, especially the 1000hr.

Coastal Marshes
The fuel models for these EVT(s) remain the same, but they are more prone to having significant building debris, and the herbaceous component is considered fully cured. Therefore, what was a live herbaceous load is transferred to dead herbaceous. New available fuels that are hazardous could also be within the fuel profile.

Prairie
The fuel characteristics for these vegetation types do not change. The fuel conditions are best defined by the Low load, Very Course, Humid Climate Grass (Dynamic Fuel Model GR3).

Western Coastal Plain (East Texas/Western Louisiana Piney Woods)

Pine Sandhill and Pine Forests
The primary change within these forests is a result of wind damage to the overstory trees. This damage occurred in the heavily thinned stands or where leave trees were left. This wind damage can create significant increases in fuel loadings and fuel bed depths. Therefore, the following standard fuel models ranging from shrub, timber litter, and slash blowdown are used to describe the light and moderate damage levels for this vegetation type. Where the blowdown is scattered and many trees are still standing is best described by the Moderate Load Activity Fuel or Low Load Blowdown (Fuel Model SB2). Where blowdown is moderate with trees compacted near the ground, the High Load Activity Fuel or Moderate Load Blowdown (Fuel Model SB3) is representative of the fuel conditions. Where contiguous, not recently thinned healthy stands were observed, no damage had occurred.

Pine Savannah Wetlands

The Longleaf Pine-Slash Pine vegetation types are prone to extensive blowdown under light and moderate damage levels because they grow fairly rapidly and don't have the wood strength to resist wind damage. Therefore, an increase in wind damaged trees results in greater blowdown damage. Those areas most prone to blowdown were along stand edges or in recently harvested areas, and the stands managed for Red-cockaded woodpecker in the National Forests. Where the blowdown is scattered and many trees are still standing is best described by the Moderate Load Activity Fuel or Low Load Blowdown (Fuel Model SB2). Where blowdown is moderate with trees compacted near the ground, the High Load Activity Fuel or Moderate Load Blowdown (Fuel Model SB3) is representative of the fuel conditions.

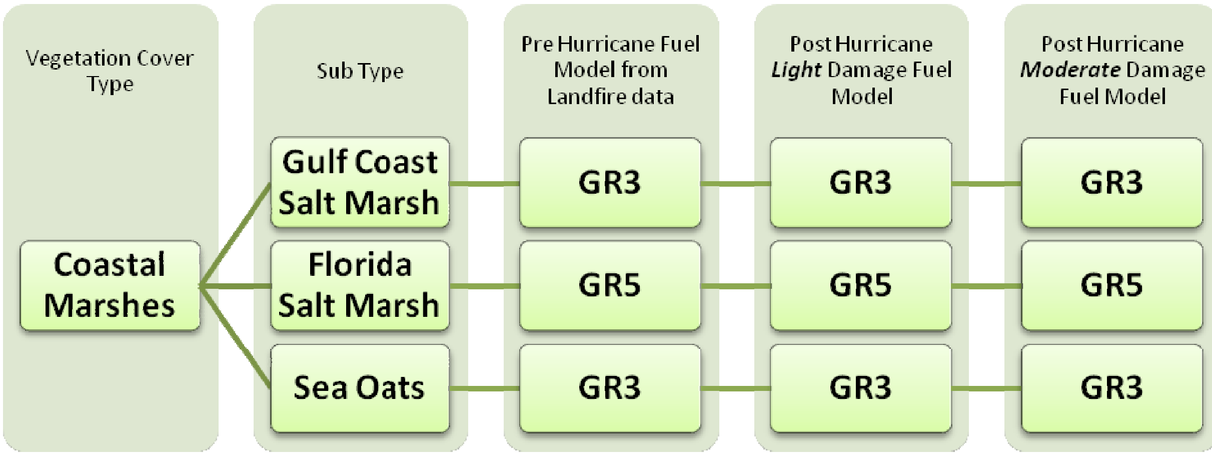
Bottomland Hardwood Swamp

The damage associated with high wind speeds in these vegetation types is primarily due to trees blowing over and increasing the amount litter and large downed woody debris. Most of the damage within the hardwood stands is considered moderate intensity. Within the Coastal Plain Swamps, Small Downed Logs (Fuel Model TL4) is representative of the fuel conditions. Areas with high concentrations of broadleaf litter and needle drape are classified as a Very High Load Broadleaf Litter (Fuel Model TL9). A fuel type that has a heavy load forest litter that includes large diameter downed logs is a classified as a Fuel Model TL7. The area where the primary carrier of fire is light dead down fuel as result of scattered wind damage is best represented by Low Load Activity Fuel (Fuel Model SB1).

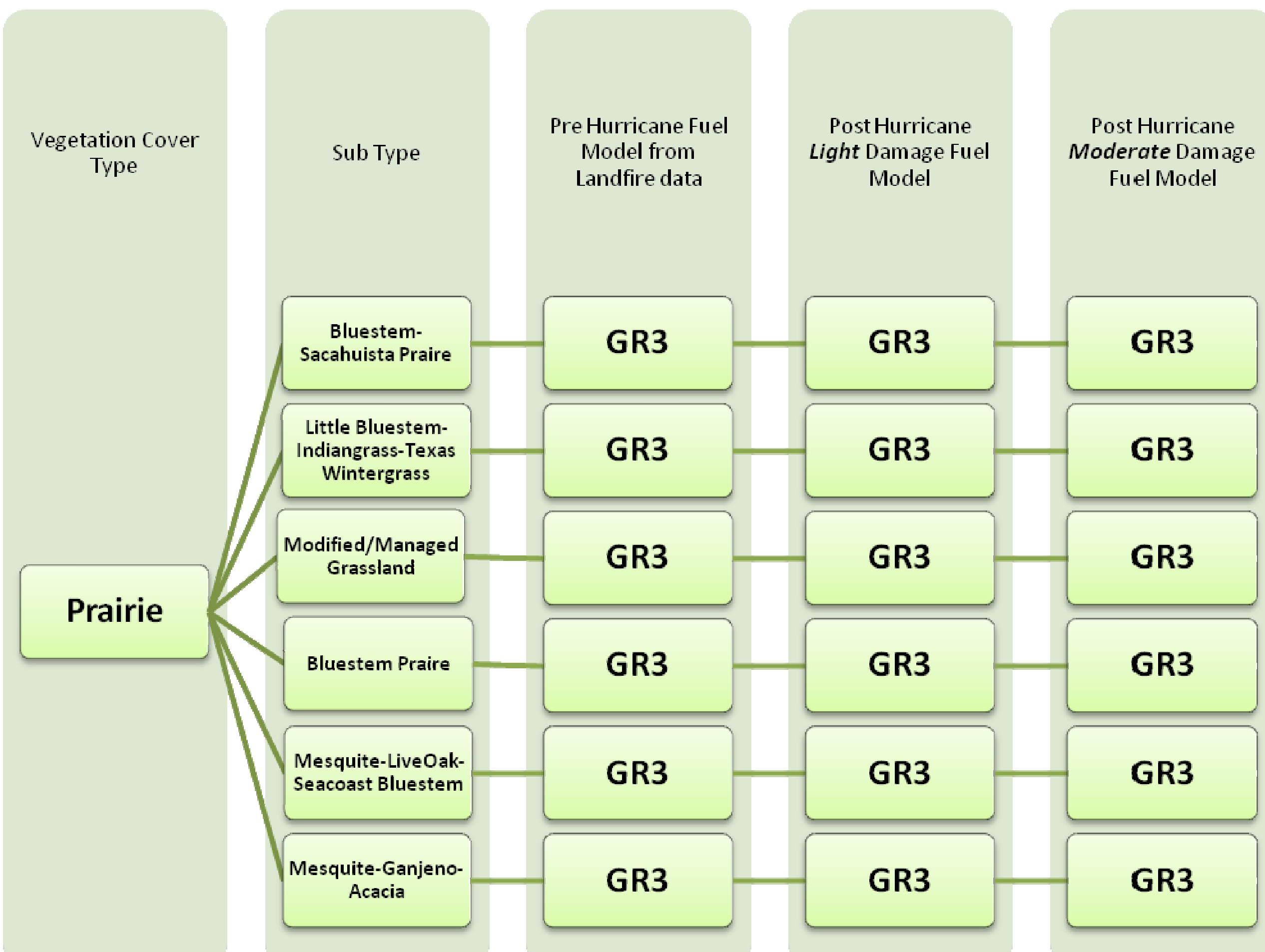
Post Hurricane Fuel Model Flow Charts

The following flow charts depict the classification of LANDFIRE Existing Vegetation Types (EVT) into more generic vegetation cover types commonly used in this geographic area, the pre-hurricane fuel model assigned to each EVT, and the resultant post-hurricane fuel model based on damage severity level.

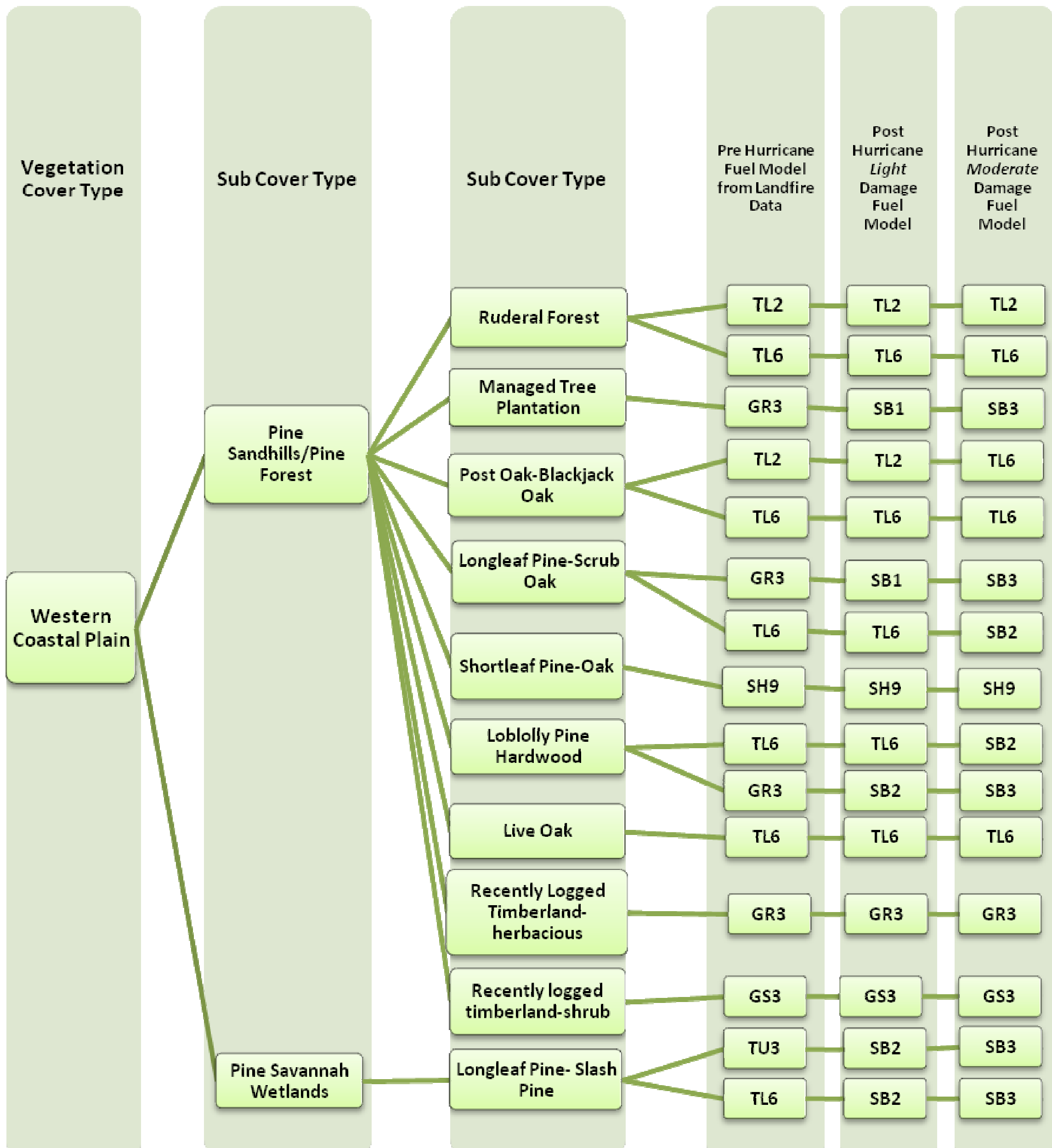
Coastal Marshes Vegetation Cover Type



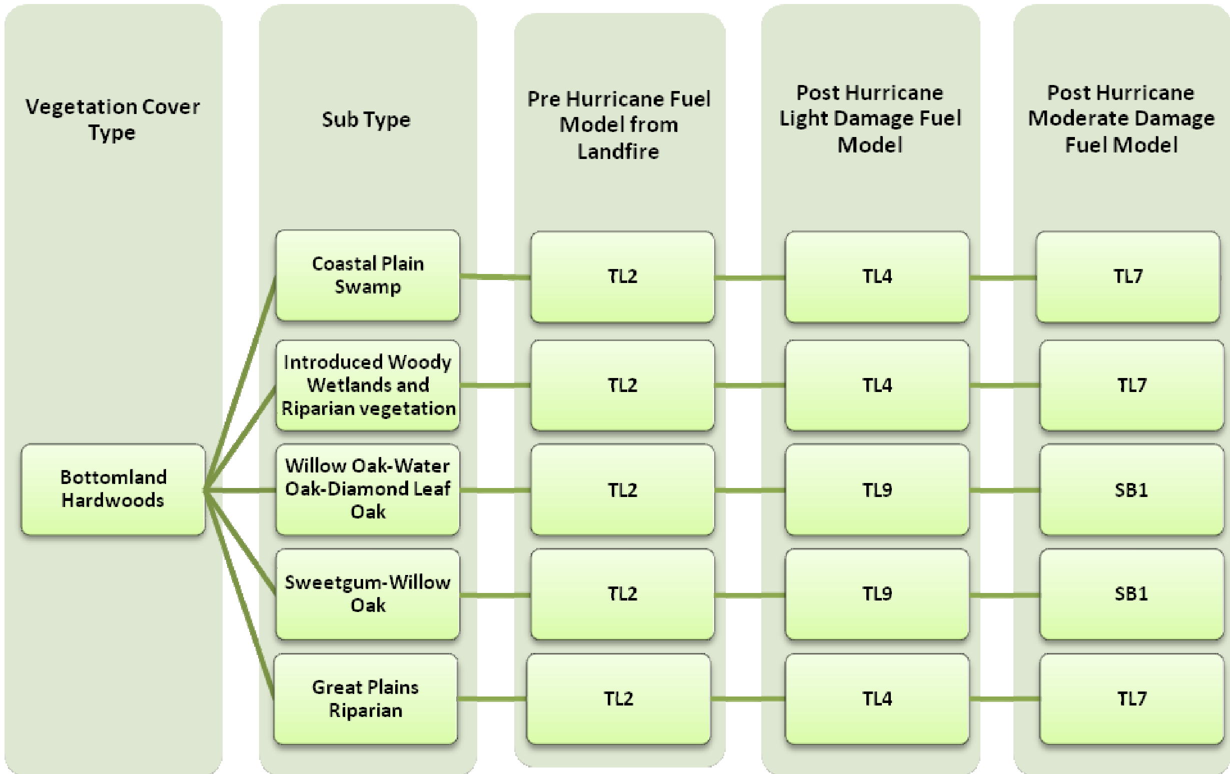
Prairie Vegetation Cover Type



Western Coastal Plain Vegetation Cover Type



Bottomland Hardwoods Vegetation Cover Type

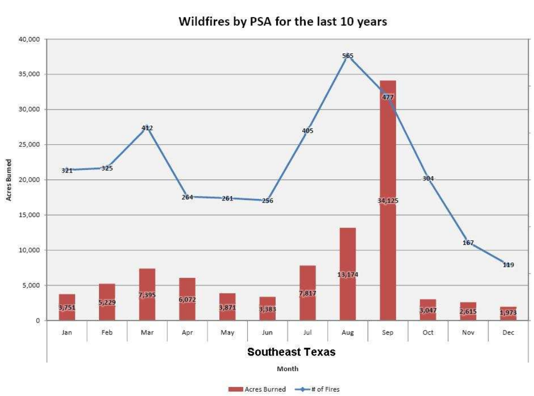


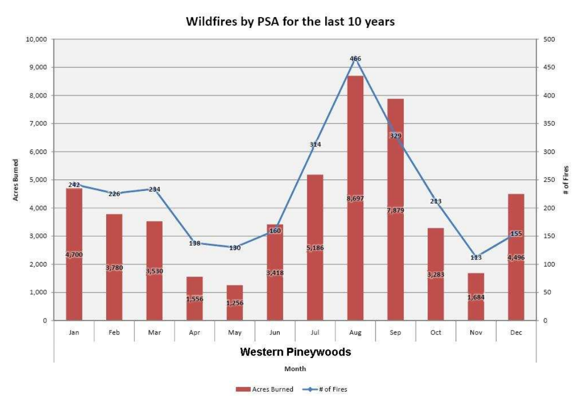
FIRE SEASON CLIMATOLOGY AND PERCENTILE WEATHER

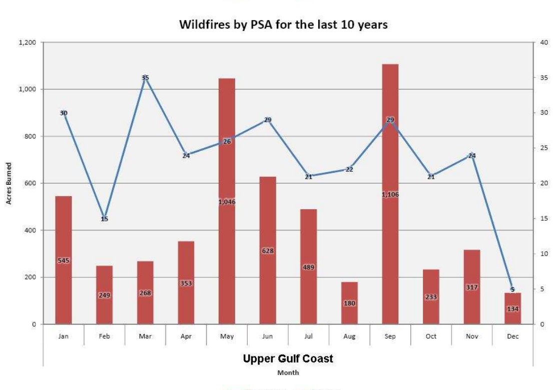
Texas Interagency Coordination Center – Predictive Services provided the framework for evaluating fire season climatology and developing the fire behavior inputs for fuel moistures and wind speeds. These inputs were then used to calculate expected fire behavior in post-hurricane fuels. In East Texas, the Texas State Forest Service divides the year into two distinct periods for the purpose of defining the fire season. The "green season" generally occurs from June 1st to November 15th and the "cured season" generally occurs from November 15th to April 30th (Using Class Days to Forecast Daily Fire Risk, TICC).

As is typical throughout most of the southeastern states, as the hurricane season draws to a close, the high pressure over the western Atlantic that has circulated warm and moist air over the region for most of the summer is replaced by drier air that infiltrates from the north. This marks the onset of the cured season, a drying trend beginning late in the year that continues into the following year with the maximum potential for fire activity by February and March. This time of the year also has the greatest wind event potential though widespread precipitation can also occur. Green-up occurs by the end of March and by the end of May the drier airmass retreats to the north allowing warmer, moister air to again become increasingly dominant signaling the onset of the green season. As temperatures increase over the summer months dead fuel moistures in the pine stands decrease enough to support active burning from July through September. This period typically has more fire activity than any other period of the year. Tropical cyclone activity peaks during this period with windy/dry conditions in advance of any storms followed by copious moisture. Depending on the frequency and intensity of storms that track onshore along the western Gulf Coast the fire potential can be greatly reduced during this period as has been the case in 2008.

Three Predictive Service Areas (PSA's) in East Texas were affected significantly by Hurricane Ike from the standpoint of damage to vegetation and the implications of increased wildfire risk; the Southeast Texas PSA, the Western Pineywoods PSA and the Upper Gulf Coast PSA.

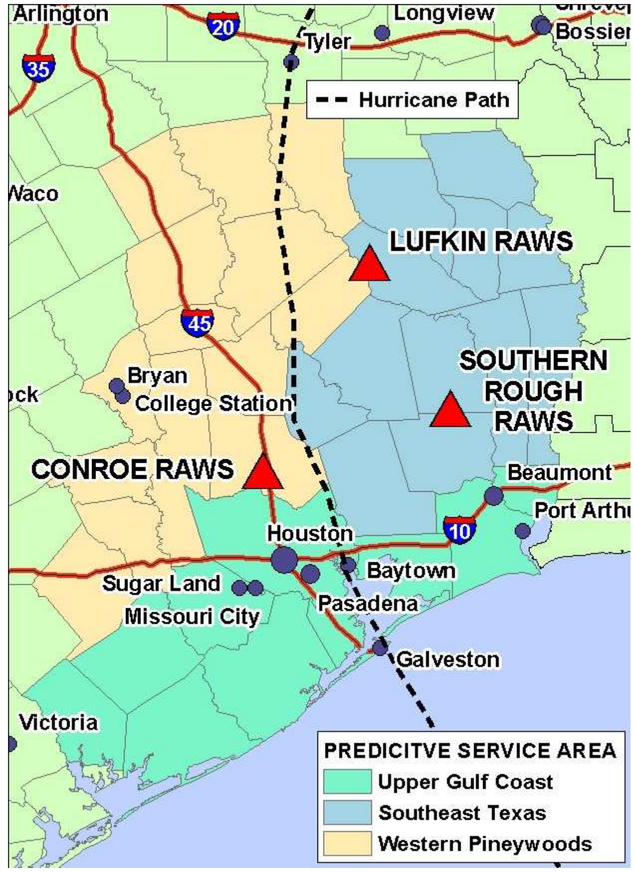


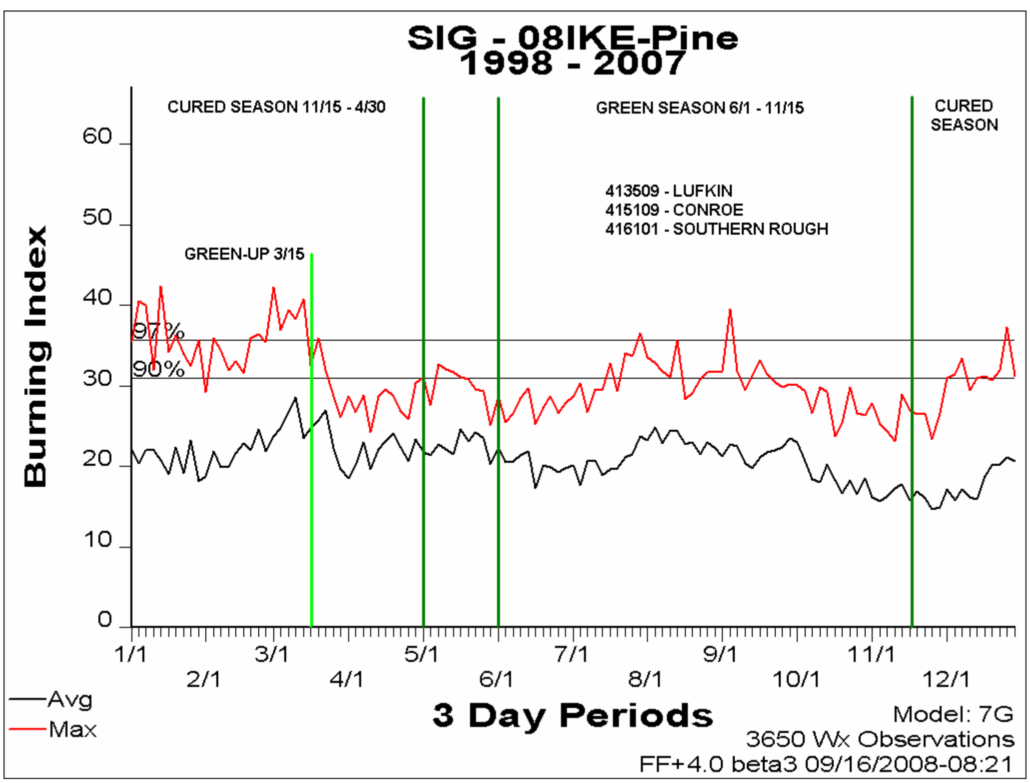




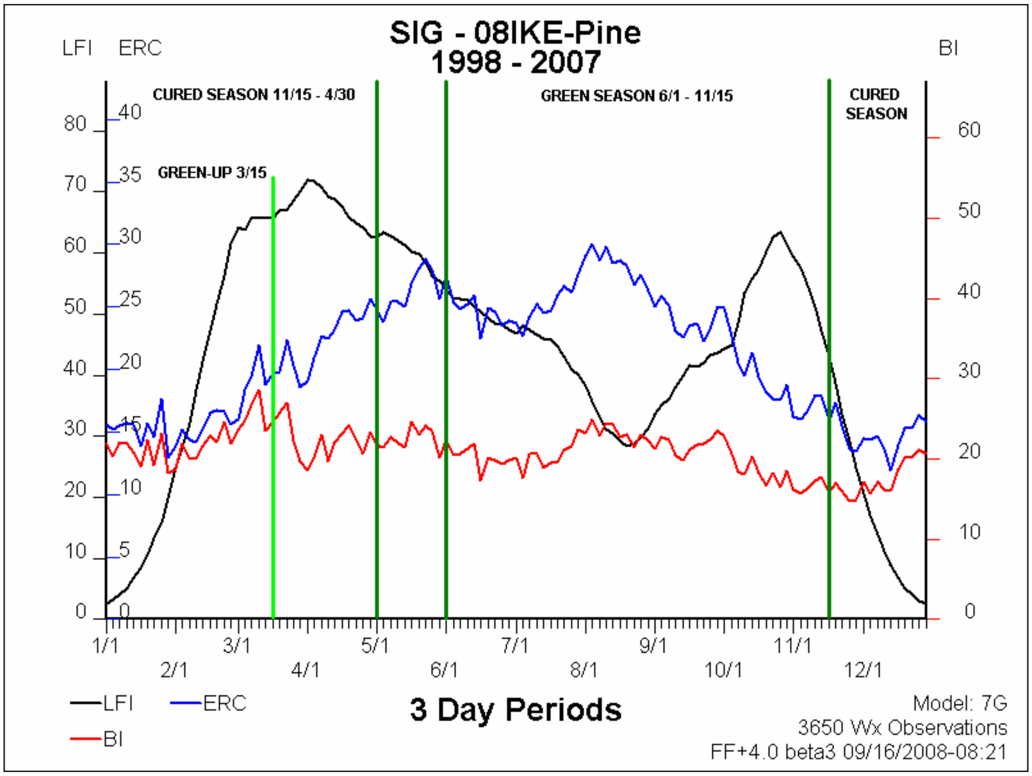
Looking at historical fire occurrence over the last 10 years in each PSA a pattern is evident of increased fire frequency (blue line) during the first three months of the year during the cured season and during July - September during the green season in the Southeast Texas and Western Pineywoods PSA's. The Upper Gulf Coast PSA shows a peak in fire frequency during March but the numbers of fires are much lower comparatively. The increased threat from wildfires resulting from Hurricane Ike will be in the Southeast Texas and Western Pineywoods PSA's.

The 08IKE-Pine SIG was created in FireFamily Plus which includes the Lufkin, Conroe and Southern Rough Remote Automated Weather Stations (RAWS). These three stations are representative of historical weather over an area that covers the path of Hurricane Ike where the most damage in forested areas occurred. Historical weather data taken from these stations was examined for climatological trends in fire weather. Previous hurricane assessments completed in the Southern Area used the most recent ten years of historical weather data to represent climatology and to better reflect the shift in climate conditions in the more recent past. The Texas State Forest Service has concluded that Burning Index (BI) in the fuel model G (7G) correlates best to local fire business for the green season and cured season (Using Class Days to Forecast Daily Fire Risk, TICC). For the 08IKE-Pine SIG, using a time period of 1998–2007 and fuel model G, the trend for BI shows a period of elevated values that closely corresponds to the cured season and a period of lower values that corresponds to the green season. A period of elevated values in August and September is also evident. The rapid decline in values during the month of March is a result of the green-up date being established on 3/15.





The Live Fuel Index (LFI) in FireFamily Plus for the 08IKE-Pine SIG shows that green-up begins when the index value rises above 50 or near the beginning of March and that live fuel moisture peaks near the end of March. A green-up date of 3/15 is established in FireFamily Plus as an average green-up date for each year in the 10 year period. The decline in index values for both BI and ERC are evident as they correspond to both the green-up date and the LFI maximum. Note also the corresponding increase in ERC/BI and decrease in LFI through July, August and September all of which correspond to the increase in fire occurrence during that period. A second less vigorous rise in live fuel moistures occurs later in the year reducing fire potential until leaf-off and the beginning of the cured season.



The Texas State Forest Service uses specific percentile breakpoints relative to levels of fire risk, fuel conditions and fire danger (Firefighters Guide to Percentiles and Thresholds, TICC). These breakpoints were used to establish percentile classes into which were grouped wind speeds and calculated fuel moistures from historic daily weather observations for the period 1998-2007. A single RAWS station must be used to develop these values and the Lufkin RAWS was selected out of the three stations in the 08IKE-Pine SIG because it has the most complete record of daily observation data. Percentile Weather in FireFamily Plus was used to develop these values separately for the cured season, the green season and for the whole year respectively using the analysis variable of BI. Since the Percentile Weather only allows four percentile classes the 0-49 and 50-74 percentile classes were grouped into one class 0-74. Resulting values for 1000 hr. fuel moistures were manually adjusted to more closely match the critical threshold values established for the Southeast Texas and Western Pineywoods PSA's. Resulting values for herbaceous fuel moistures that were calculated to be below 30 were adjusted to 30 (cured) which is the minimum value accepted by fire behavior calculation programs

PERCENTILE CLASSES				
0 - 49	**50 – 74**	**75 – 89**	**90 – 96**	**97+**

Percentile Weather

Values developed from Percentile Weather in FireFamily Plus. Values for the "Cured Season" were selected for input into fire behavior calculations using post-hurricane fuel conditions for modeling fire behavior implications *over the next several months*.

FireFamily Plus Percentile Weather Report

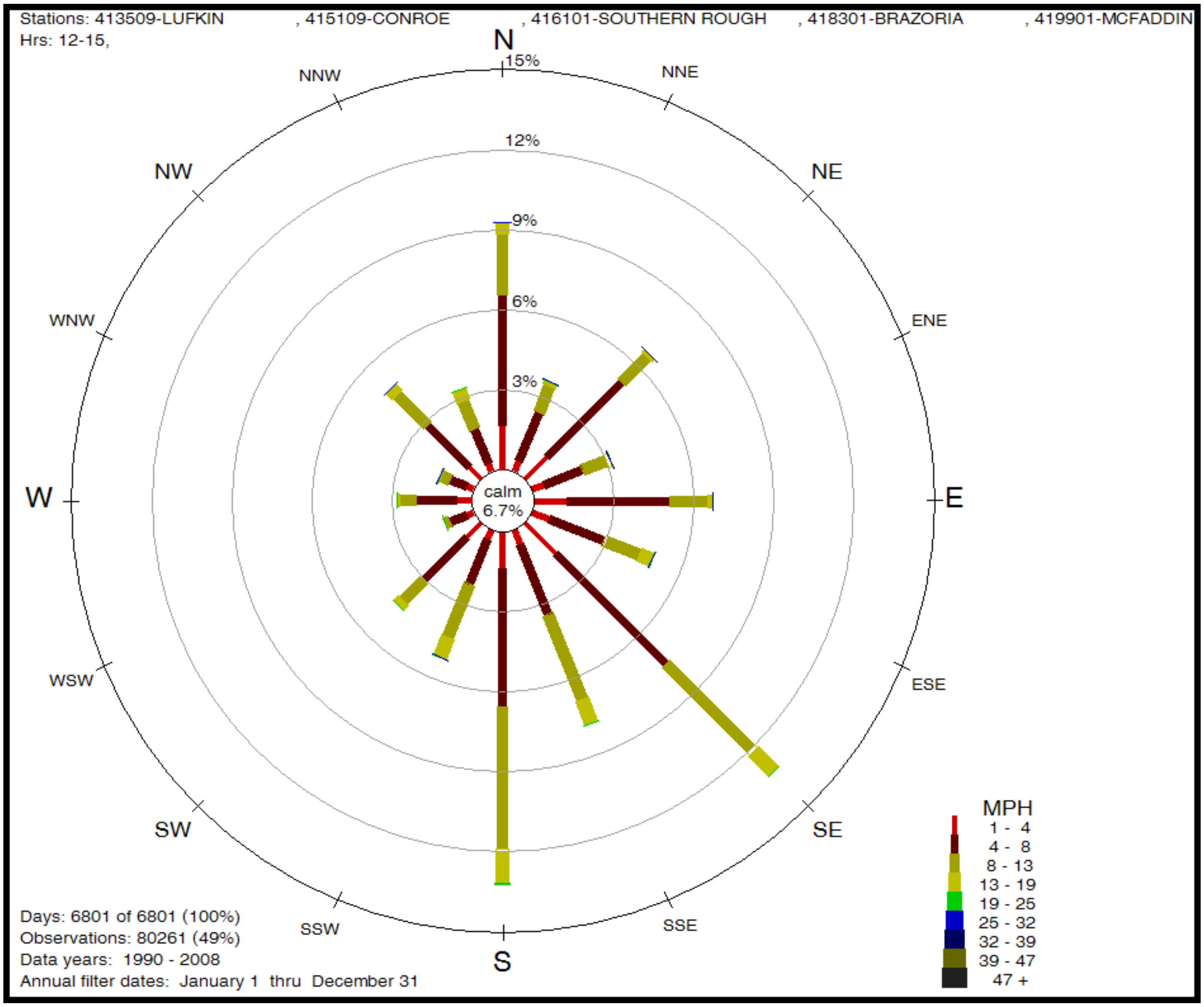
Station: 413509: LUFKIN   Variable: BI
Model: 7G1PE3
Data Years: 1998 – 2007
Wind Directions: N, NE, E, SE, S, SW, W, NW

	"Cured Season"				***"Green Season"***				***Entire Year***			
	Date Range: November 15 - April 30				Date Range: June 1 - November 14				Date Range: January 1 - December 31			
Percentiles, Probabilities, and Mid-Points												
Variable/Component Range	Low-Mod	High	VH	Ext	Low-Mod	High	VH	Ext	Low-Mod	High	VH	Ext
Percentile Range	0 - 74	75 - 89	90 - 97	98 - 100	0 - 74	75 - 89	90 - 97	98 - 100	0 - 74	75 - 89	90 - 97	98 - 100
Climatol. Probability	74	15	8	3	74.00	15	8	3	74	15	8	3
Mid-Point BI	18 - 18	30 - 30	36 - 36	48 - 48	19 - 19	27 - 27	31 - 31	37 - 40	18 - 18	30 - 30	36 - 36	44 - 44
Num Observations	100	115	40	10	75	78	46	17	284	240	103	14
Calculated Spread Comp.	3	6	8	13	2	4	4	7	2	5	7	12
Calculated ERC	18	25	33	41	23	29	32	36	21	27	32	37
Fuel Moistures												
1 Hour Fuel Moisture	11	8	7	4	10	7	7	6	11	8	8	6
10 Hour Fuel Moisture	13	10	9	6	11	9	9	7	12	10	9	8
100 Hour Fuel Moisture	18	17	17	14	18	16	16	15	18	17	17	16
Herbaceous Fuel Moisture	82	53	30	30	117	104	97	93	107	78	57	30
Woody Fuel Moisture	117	97	80	70	149	136	127	123	138	113	100	85
20' Wind Speed	4	7	8	10	4	6	7	9	4	7	9	12
1000 Hour Fuel Moisture	21	17	16	15	19	18	17	16	20	19	17	16

Note: Highlighted column is weather parameters used in Fire Behavior Analysis and Implications

Wind Analysis

Winds in the area of concern are represented by a special interest group consisting of five RAWS sites. As can be seen below winds are predominantly from the south-southeast but can also come from the north up to nine percent of the time. When wind direction is from the south-southeast there is a high probability that the wind speed will exceed eight MPH. Winds from the north can also have significant strength but tend to be lighter than winds from southerly directions.



FIRE BEHAVIOR IMPLICATIONS

Introduction

The Fire Behavior Fire Characteristics Chart or “Haul Chart” was selected as the primary means to describe the specific fire behavior outputs for each of the vegetation types and corresponding fuel models. A definition and description of the Haul Chart will provide the foundation for how the fire behavior outputs will be displayed.

Fire behavior is described most simply in terms of fireline intensity (in feet of flame length) and in rate of spread (in chains per hour). The Fire Behavior Fire Characteristics Chart or “Haul Chart” as firefighters call it (Andrews and Rothermel, 1982), plots fire behavior in terms of heat per unit area released (as BTU’s per square foot, as the X axis) versus rate of spread (as chains per hour, as the Y axis). The Haul Chart is an excellent tool for measuring the safety and effectiveness of various fireline resources (Stubbs 2005).

An adjective rating for low, moderate, high, very high, and extreme is used to describe fire behavior characteristics. This approach is similar to how National Fire Danger Rating System adjective ratings describe the “fire danger” for a given parcel of wildland. The adjective rating for fire behavior characteristics is appropriate for description over larger geographic areas.

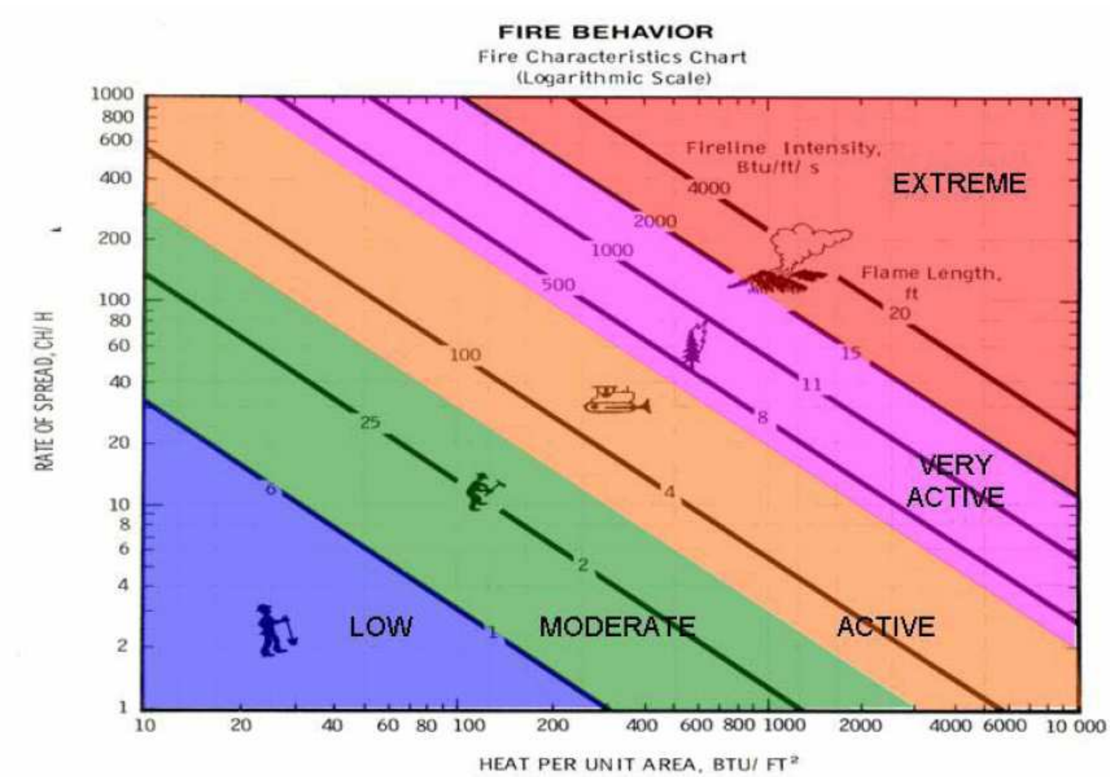
The computer program NEXUS 2.0 (2005 version) was used to predict fire behavior characteristics for the adjective ratings. Percentile weather from the Lufkin weather station was used to develop fire weather and fuel inputs for a November 15 through April 30 time period. The specific fire behavior outputs for each fire behavior adjective rating are based on the “Very High” fire danger rating used for the NEXUS weather inputs (see highlighted section of Percentile Weather Chart—*Cured Season* for parameters). The outputs for each of the fire danger ratings are located in Appendix D.

The fireline interpretation of the Haul Chart as modified by Tim Stubbs (2005) describes in simple terms the intensity of the fire behavior to be expected and then the implications to firefighter effectiveness and safety. An explanation of the Adjective Ratings and their relationship to the “Haul Chart” is on the next page.

Adjective Ratings for Fire Behavior

ADJECTIVE RATING	FLAME LENGTH	IMPLICATION
LOW	0-1	Fire will burn and will spread however it presents very little resistance to control and direct attack with firefighters is possible.
MODERATE	1-3	Fire spreads rapidly presenting moderate resistance to control but can be countered with direct attack by firefighters.
ACTIVE	3-7	Fire spreads very rapidly presenting substantial resistance to control. Direct attack with firefighters must be supplemented with equipment and/or air support.
VERY ACTIVE	7-15	Fire spreads very rapidly presenting extreme resistance to control. Indirect attack may be effective. Safety of firefighters in the area becomes a concern.
EXTREME	>15	Fire spreads very rapidly presenting extreme resistance to control. Any form of attack will probably not be effective. Safety of firefighters in the area is of critical concern.

Fire Characteristics (Haul) Chart Including Adjective Ratings for Fire Behavior



Fire Behavior Specific to Vegetation Cover Types

Coastal Marshes and Prairies

The major fire behavior implication to the marshes and prairies is dependent on the amount and duration of inundation from storm surge. Fresh water marsh grasses and prairie grasses cannot tolerate any salt water intrusion. In addition, many salt water marsh grasses cannot tolerate long periods of total submersion. In the short term, these areas of dead grass could result in more dead fine fuels that are receptive to fire spread or in the long-term could result in areas that become completely fire proof (convert to mud flats) if the grasses are unable to regenerate (Cross, et al 2005). The building debris and potential hazardous materials such as oil could add to increase in the overall fire intensity and duration. Although it is intuitive there would be a significant change in fire behavior characteristics, these conditions can not be modeled.

Coastal Marshes Fire Behavior Adjective Ratings

Existing Vegetation Types	Pre-Fuel Model	Potential Fire Behavior Adjective Rating at Very High Weather Conditions		
		Pre-Hurricane	Post-Hurricane	
			Light Damage	Moderate Damage
Gulf Coast Salt Marsh	GR3	Moderate	Active	Active
Sea Oats	GRS	Moderate	Moderate	Moderate
Florida Salt Marsh	GR5	Active	Very Active	Very Active

Prairie Fire Behavior Adjective Ratings

Existing Vegetation Types	Pre-Fuel Model	Potential Fire Behavior Adjective Rating at Very High Weather Conditions		
		Pre-Hurricane	Post-Hurricane	
			Light Damage	Moderate Damage
Modified/Managed Grassland	GR3	Moderate	Moderate	Moderate
Bluestem Prairie	GR3	Moderate	Moderate	Moderate
Mesquite-Live Oak-Seacoast Bluestem	GR3	Moderate	Moderate	Moderate
Mesquite-Ganjeno-Acacia	GR3	Moderate	Moderate	Moderate
Bluestem-Sacahuista Prairie	GR3	Moderate	Moderate	Moderate
Little Bluestem-Indiangrass-Texas Wintergrass	GR3	Moderate	Moderate	Moderate

Pine Sandhill and Pine Forests

These forests have a wide range of fuel conditions depending upon the existing vegetation and the post hurricane damage levels. Fire behavior outputs for the slash and blowdown fuel models are characterized by a slight increase in rate of spread and a greater increase in flame lengths and fire intensity. For those stands that were recently thinned or harvested, the surface fuels will no longer be sheltered from the wind and shaded the sun. Therefore, these areas will have greater increases in fire intensity with some increase fire rates of spread and flame lengths.

Fire Behavior Adjective Ratings

Existing Vegetation Types	Pre-Fuel Model	Potential Fire Behavior Adjective Rating at Very High Weather Conditions		
		Pre-Hurricane	Post-Hurricane	
			Light Damage	Moderate Damage
Ruderal Forest	TL2	Low	Low	Low
	TL6	Moderate	Moderate	Moderate
Recently Logged Timberland - Herbaceous	GR3	Moderate	Moderate	Moderate
Recently Logged Timberland - Shrub	GS3	Very Active	Very Active	Very Active
Managed Tree Plantation	GR3	Moderate	Moderate	Moderate
Post Oak-Blackjack Oak	TL2	Low	Low	Low
	TL6	Moderate	Moderate	Moderate
Longleaf Pine-Scrub Oak	GR3	Moderate	Moderate	Active
	TL6	Moderate	Moderate	Active
Shortleaf Pine-Oak	SH9	Very Active	Very Active	Very Active
Loblolly Pine-Hardwood	TL6	Moderate	Moderate	Active
	GR3	Moderate	Active	Active
Live Oak	TL6	Moderate	Moderate	Moderate

Pine Savannah Wetlands

Dependent on the level of damage, these forest types typically burn at moderate rates of spread under drought conditions. If conditions are wetter, fire behavior will consist primarily of smoldering ground fire with slow rates of spread. For those areas that have light or moderate damage to the overstory, the fire behavior will increase substantially causing greater resistance to control throughout the entire fire season. Fire intensity and severity will increase significantly.

Fire Behavior Adjective Ratings

Existing Vegetation Types	Pre-Fuel Model	Potential Fire Behavior Adjective Rating at Very High Weather Conditions		
		Pre-Hurricane	Post-Hurricane	
			Light Damage	Moderate Damage
Longleaf Pine-Slash Pine	TU3	Active	Active	Active
	TL6	Moderate	Active	Active

Bottomland Hardwoods

Under normal climatic and weather conditions, bottomland hardwood swamps are barriers to fire spread. Typically, fires are infrequent in the mixed wetland hardwoods of the Southeast due to wet conditions and high moisture levels in the organics and litter, but if flammable vegetation such as pine forest, marsh or prairie is adjacent fire can move into swamp forests under extreme drought conditions. In mixed hardwood swamps fire occurrence is on the scale of one fire per century. Where drainage of swamps accelerates litter buildup and increases productivity, fires are usually more severe. Only surface fire spread was calculated for this assessment. The conditions described above could be modeled if crown fire was enabled to calculate the desired outputs (Kim Ernstrom, FMO Florida Panther Refuge, personal communication). Specific to the Willow Oak, Water Oak, Diamond Oak, and Sweetgum-Willow Oak EVT(S), the short term fire behavior increases in those areas that have light damage because only the leaves have blown off the trees. The additional leaf litter increases the rate of spread and flame lengths. With moderate damage, the entire tree blows over creating a greater heavy fuel load that is more compact, sheltering the fine fuels from the wind.

Fire Behavior Adjective Ratings

Existing Vegetation Types	Pre-Fuel Model	Potential Fire Behavior Adjective Rating at Very High Weather Conditions		
		Pre-Hurricane	Post-Hurricane	
			Light Damage	Moderate Damage
Great Plains Riparian	TL2	Low	Low	Low
Coastal Plain Swamp	TL2	Low	Low	Moderate
Introduced Woody Wetlands and Riparian Vegetation	TL2	Low	Low	Moderate
Willow Oak-Water Oak-Diamondleaf Oak	TL2	Low	Active	Moderate
Sweetgum-Willow Oak	TL2	Low	Active	Moderate

Fire Behavior Analysis Methods

The spatial analysis conducted for this assessment was unique in that it was the first large scale project in the southern U.S. to utilize the 40 fuel model layer from LANDFIRE. This layer formed the basis of the analysis conducted. From this data fire behavior specialists determined how the fuel bed would be changed in moderate and light damage zones.

The computer program NEXUS 2.0 was used to predict fire behavior characteristics for pre-hurricane and post-hurricane fuels conditions. The output from NEXUS is not spatial in nature; rather it is for a specific set of input values (weather, fuels and topography) provided by the user. Because the NEXUS model is non-spatial in nature these outputs were added to a table included as Appendix D. Outputs from this model will help the fire manager to plan on the ground fire tactics by giving the manager a reference on how fire behavior may change on a smaller scale in the post hurricane fuel bed.

A landscape level fire assessment was also performed for the Hurricane Ike damage assessment area. The assessment used FlamMap, to predict fire behavior characteristics across the entire assessment area. FlamMap computes potential fire behavior characteristics (spread rate, flame length, fireline intensity, etc.) for every point on a landscape using complex interactions of surface fuels, canopy fuels and topography, with constant weather and fuel moisture conditions. A fire perimeter is not predicted because there is no time element in FlamMap. Managers can use FlamMap output to design mitigation measures to protect values at risk by understanding what type of fire behavior is likely in a specific area. They can see where hazardous fire behavior might exist based on combinations of fuel, topography and wind.

The NEXUS fire behavior model only predicts fire behavior for a specific area; the spatial models account for wind direction, fuels, slope, aspect, canopy cover and tree height across an entire landscape. Both modeling approaches were included due to advantages and disadvantages of each. While NEXUS allows for very specific inputs and detailed fire behavior characteristic outputs, it does not account for spatial changes in fuels or topography.

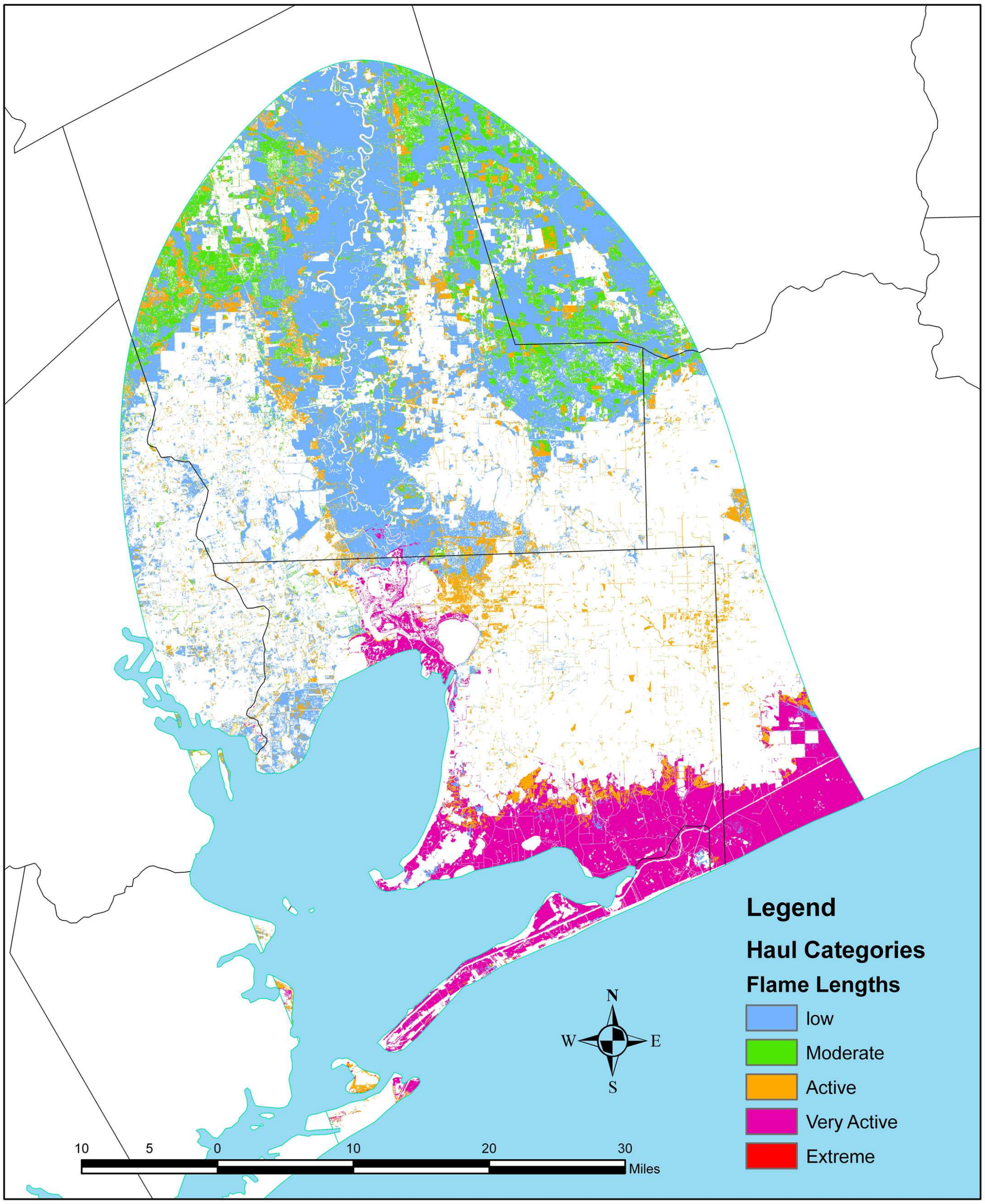
The landscape scale fire assessment approach using FlamMap is more coarse in nature. This models uses large scale data layers as inputs. Pixels of 30 square meters are used for estimating fuel inputs. The fuels input information used in this analysis was from the LANDFIRE National data (2008). These data layers are coarse compared to NEXUS inputs; however, they are consistent across all ownerships. This allows for an estimate of fire behavior across multiple ownerships using the same level of detail in the input data.

The next step was to integrate damage severity levels from the Rapid Damage Assessment model with the 40 fuel model layer. Fuel models within each damage zone were adjusted within the project to reflect the change decisions made by fire behavior specialists. When this new post hurricane landscape was complete, the assessment team was then able to run the FlamMap program to determine what fire behavior was expected in the new fuel bed given a fuel moisture regime at the 90^{th} percentile of conditions at the Lufkin RAWS site. This site was located at the northern edge of the light damage zone and had an excellent data set.

Results

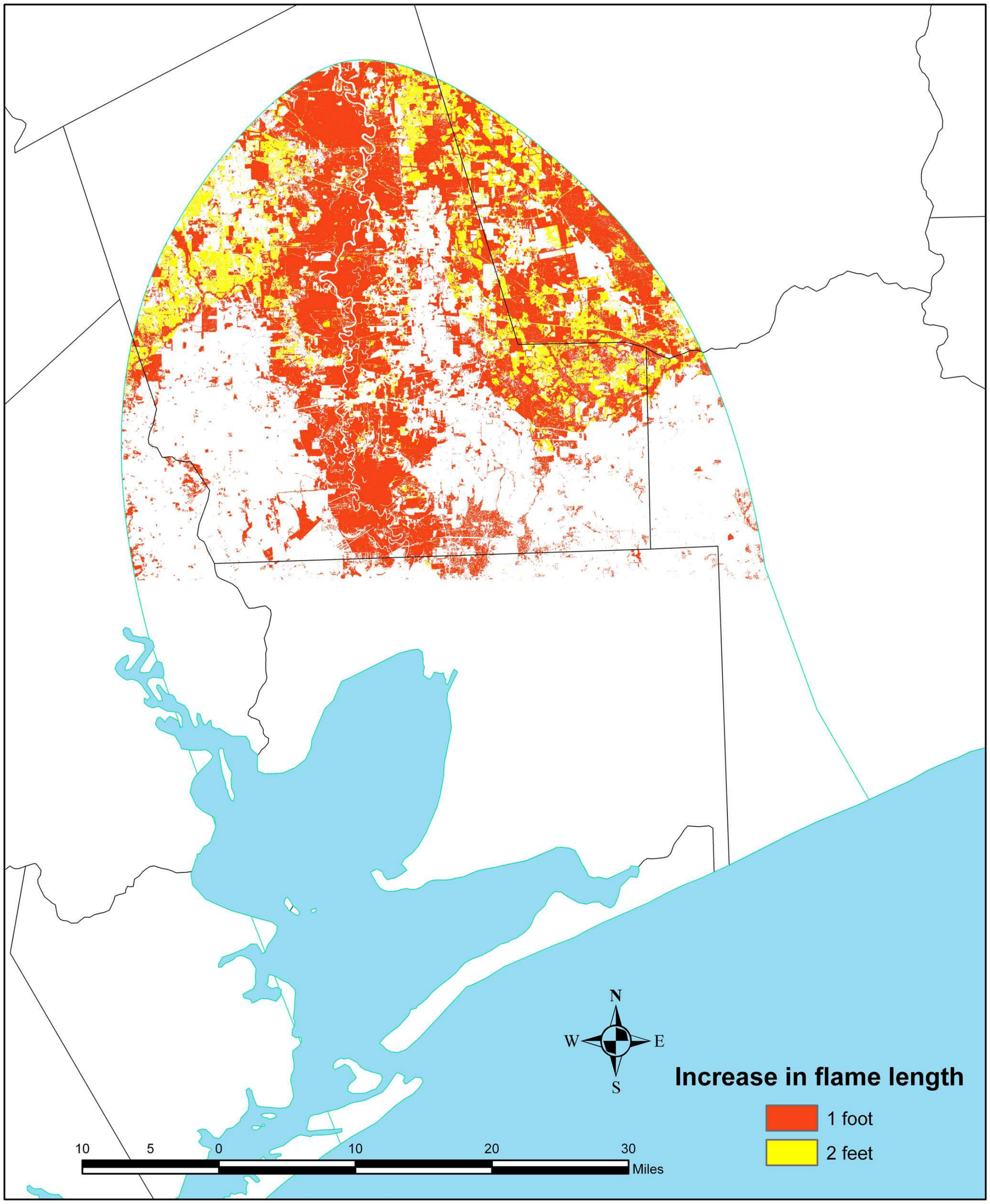
The analysis took a pre-hurricane FlamMap run and compared it to a post-hurricane run in ArcMap to detect change. The question was "where could fire managers and firefighters expect to see a change on the landscape that required them to manage fire differently than in the pre-hurricane forest?" The output from this analysis is displayed in this report as a function of the fire characteristics chart; with this chart fire personnel can visualize where critical areas of change will occur. The results are displayed on the following two pages.

FlamMap was used to show post hurricane potential flame lengths in the **moderate** damage area. These are displayed in the haul chart categories.



Post Hurricane Ike Haul Chart Categories Moderate Area

FlamMap was used to show the areas in the **moderate** damage area that had increased potential flame length due to changes in fuel conditions following hurricane Ike.



Post Hurricane Ike Increase in flame length Moderate Area

Fire Behavior Summary

The analysis determined the flame length may change in those areas with light or moderate damage in the forested vegetation cover types, and the added fuel loading will significantly change fire fighting tactics. Prior to the hurricane damage, flame lengths were within the limits for direct attack or a combination attack with small dozers (450's).

In the light to moderate damage areas, flame lengths under "normal" fuel moisture conditions may be too high for direct attack. This is due to the large amount of dead and down material available to burn. A combination and/or indirect attack will most likely be needed in the light to moderately damages areas. Fires will generally become more fuel driven. This will increase the likelihood of extreme fire behavior under moderate fuel moisture conditions. Also, spotting will become more likely due to the amount of dead fuels on the ground. The increase in heavy dead fuels, down pines, and salt killed brush has created more sources for spotting brands. The increase in fine fuels across the area will be the receptive nature of the fuel bed. The larger diameter fuels will cause fires to burn more actively into the night.

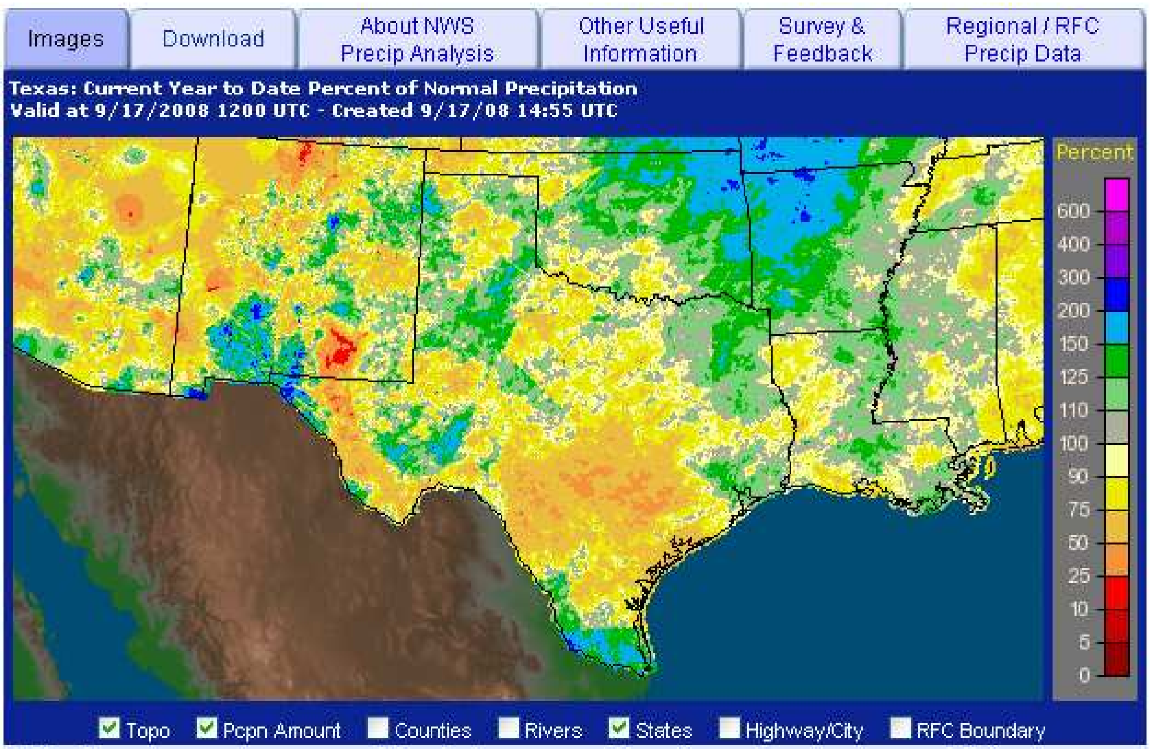
Mop-up will be more difficult and the chances for holdover will increase. Longer commitment times for fire crews will be needed and this will decrease the capabilities of initial attack resources. Smoke production will also increase presenting additional challenges for aerial operations as well as health concerns down wind. Effect on remaining overstory will be more severe with increased scorch, torching and mortality (Cross et al 2005).

SHORT, MEDIUM AND LONG RANGE OUTLOOKS

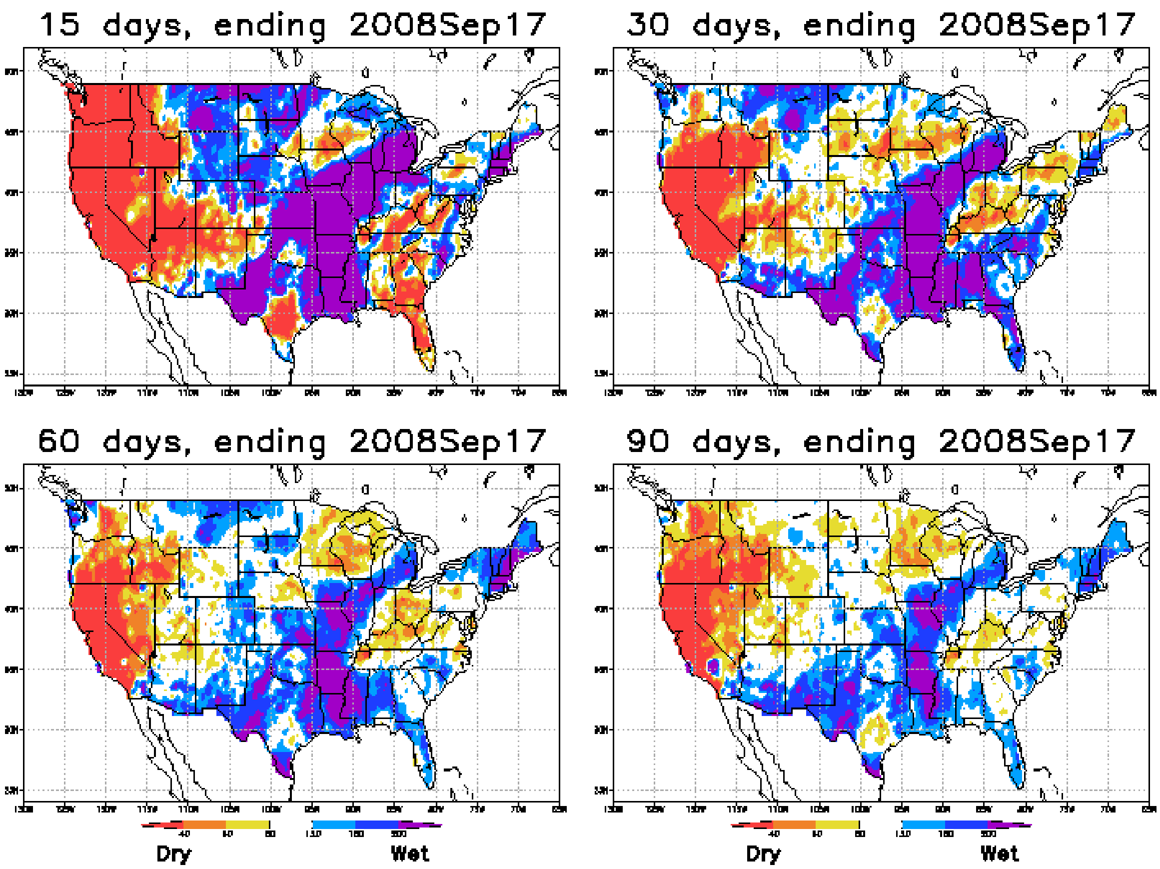
Current Situation

In 2007 above normal precipitation across most of the state of Texas provided much needed relief from the severe drought of 2005-2006. East Texas benefited from this drought relief although not to the extent of central Texas. A return to La Nina conditions during the last half of 2007 and into the first half of 2008 brought below normal moisture to east Texas leaving a deficit until the peak of the 2008 tropical cyclone season. In August of 2008 moisture left behind by flooding rains reduced the moisture deficit significantly and in September moisture brought by hurricane's Gustav and Ike brought most of east Texas up to normal to above normal precipitation amounts for the year to date.

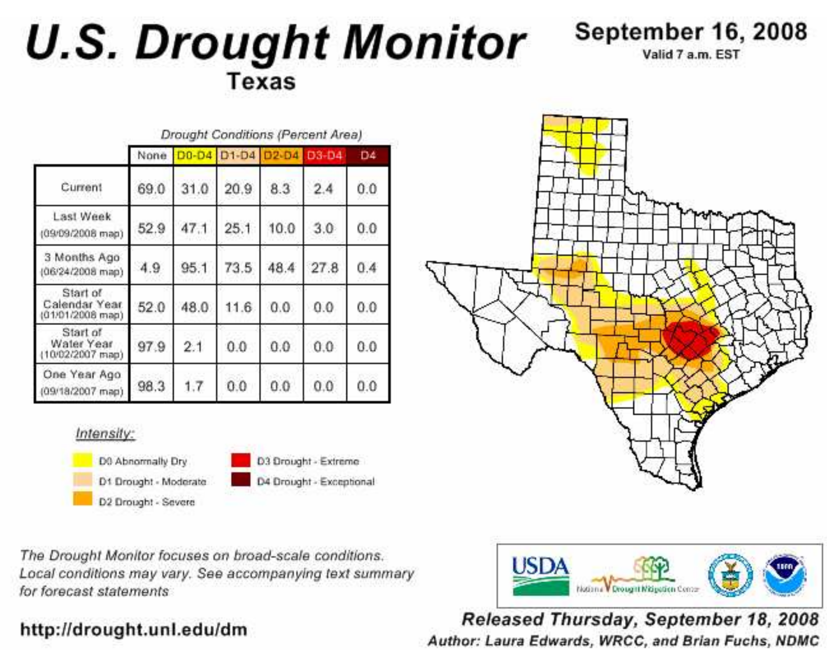
Data from NOAA's Advanced Hydrologic Prediction Service dated 9/16/08 (below) indicates that most of east Texas has received more than 100% percent of normal precipitation for the year to date. There is a band of below 100% of normal precipitation that extends across the Western Pineywoods and Southeastern Texas Predictive Service Areas (PSA's).



The 90 day Percent of Normal (%) precipitation chart (below; lower right) shows that in the previous 90 days ending 9/17/2008 normal to above normal precipitation has fallen over east Texas with portions of the Western Pineywoods and Southeastern Texas PSA's receiving the least.



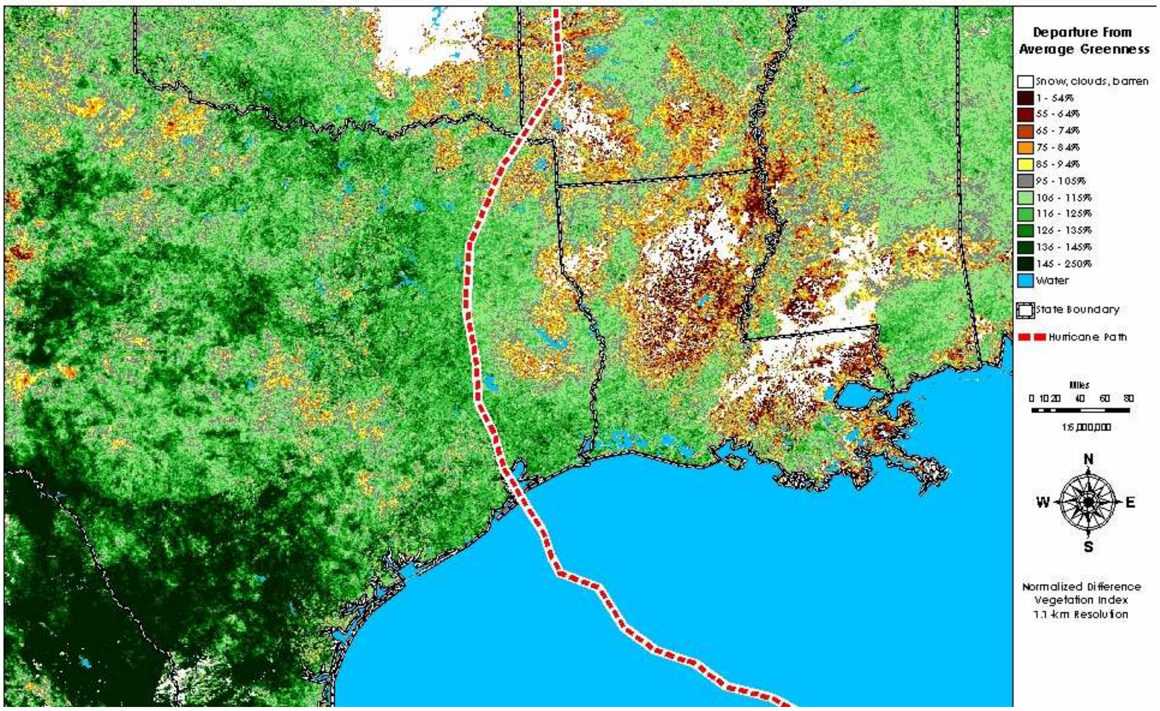
The U.S. Drought Monitor dated 9/16/2008 shows that east Texas is drought free.

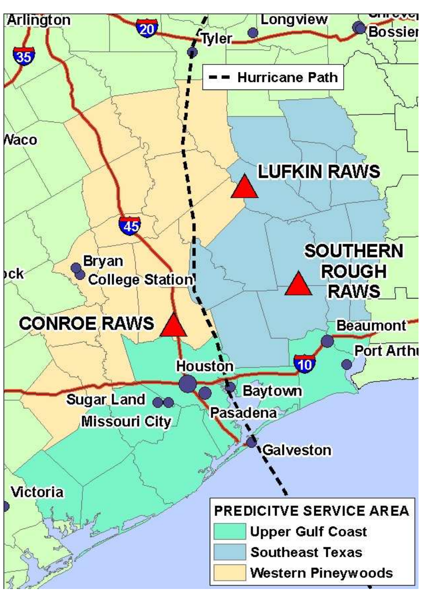


NDVI Departure from Average imagery dated 9/8/2008 shows that most areas of east Texas are exhibiting average to above average greenness (gray to green). The image indicates that portions of the Southeast Texas PSA are below average greenness. Note the areas of north central and southeastern Louisiana where cloud cover has obscured the image and produced a false interpretation. This image predates the landfall of Hurricane Ike. The image obtained dated 9/15/2008 has cloud cover obscuring the area of interest and does not give a good indication of greenness therefore is not shown, but it can be assumed that there has been an increase in greenness since the passage of Hurricane Ike.

Normalized Difference Vegetation Index (NDVI) data observed by AVHRR satellites is provided by the EROS Data Center (EDC), U.S. Geological Survey. These maps are composited weekly and have 1.1-kilometer (0.6 mile) spatial resolution. DA - Departure from Average Greenness portrays how green each pixel is compared to its average greenness for the current week of the year based on 1989-2008 data.

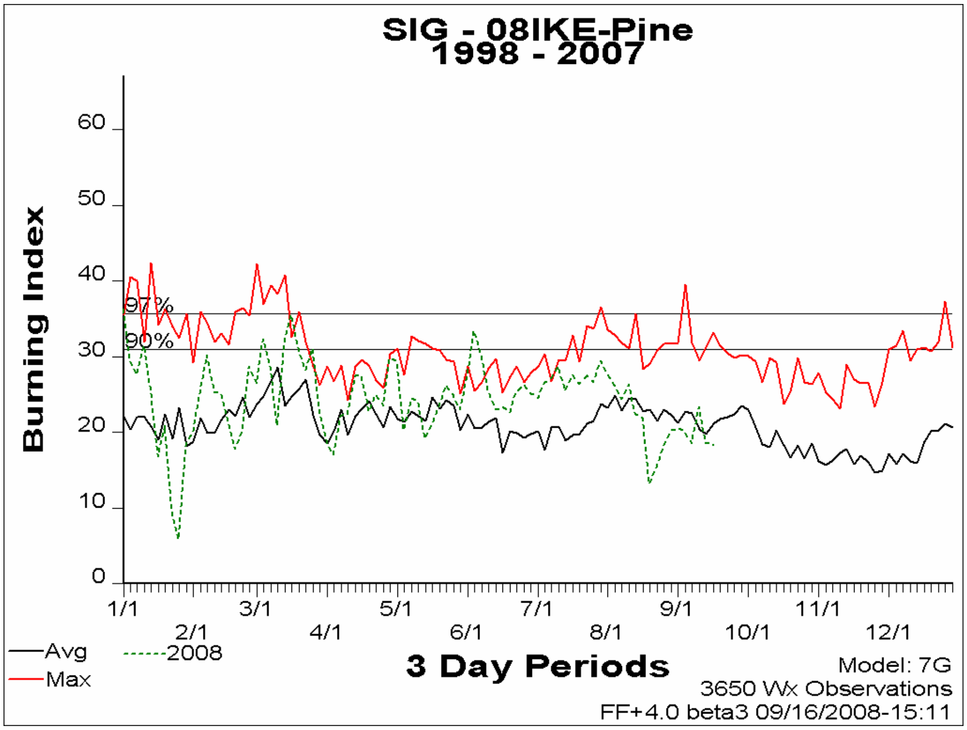
Departure from Average Greenness: September 8, 2008



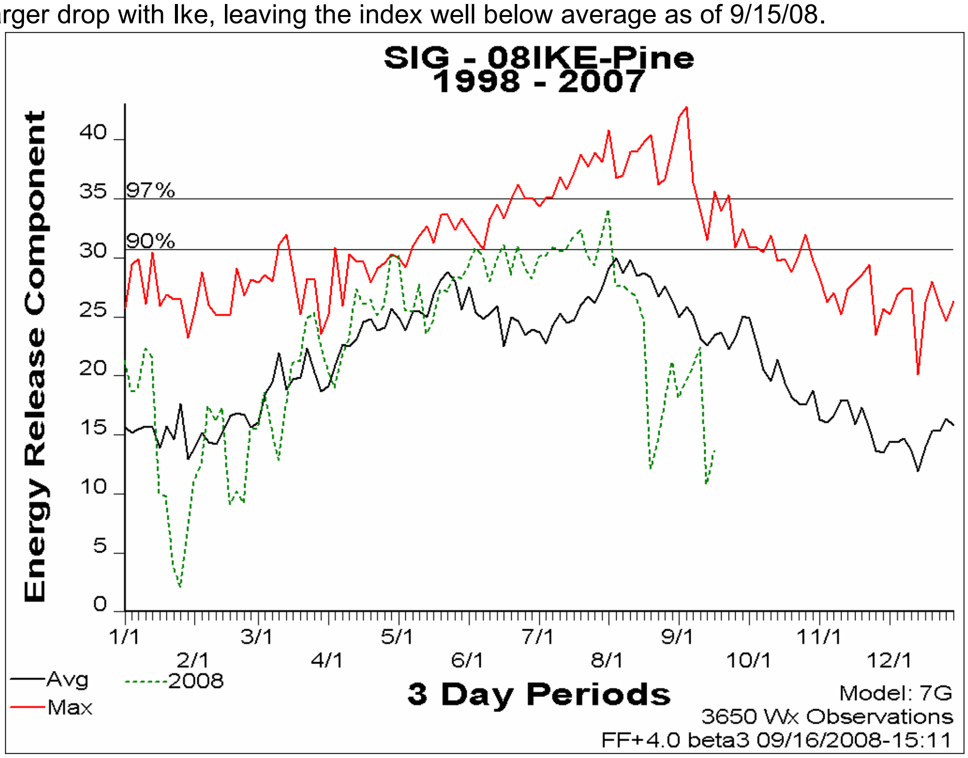


The 08IKE-Pine SIG was created in FireFamily Plus which includes the Lufkin, Conroe and Southern Rough Remote Automated Weather Stations (RAWS). These three stations are representative of historical weather over an area that covers the path of Hurricane Ike where the most damage in forested areas occurred. The charts on the following pages examine this year's trends against historical trends in Burning Index (BI), Energy Release Component (ERC), Keetch-Byram Drought Index (KBDI) and 1000-Hour Time Lag Fuel Moisture (TLFM) indices over a 10 year period (1998-2007). The black line represents the average index value over the course of the historical year. The red line represents the maximum index value reached for that day of the year over the 30 year period. The green represents the index value for each day during 2008. The value represents a running three day average. The data is valid through 9/15/2008.

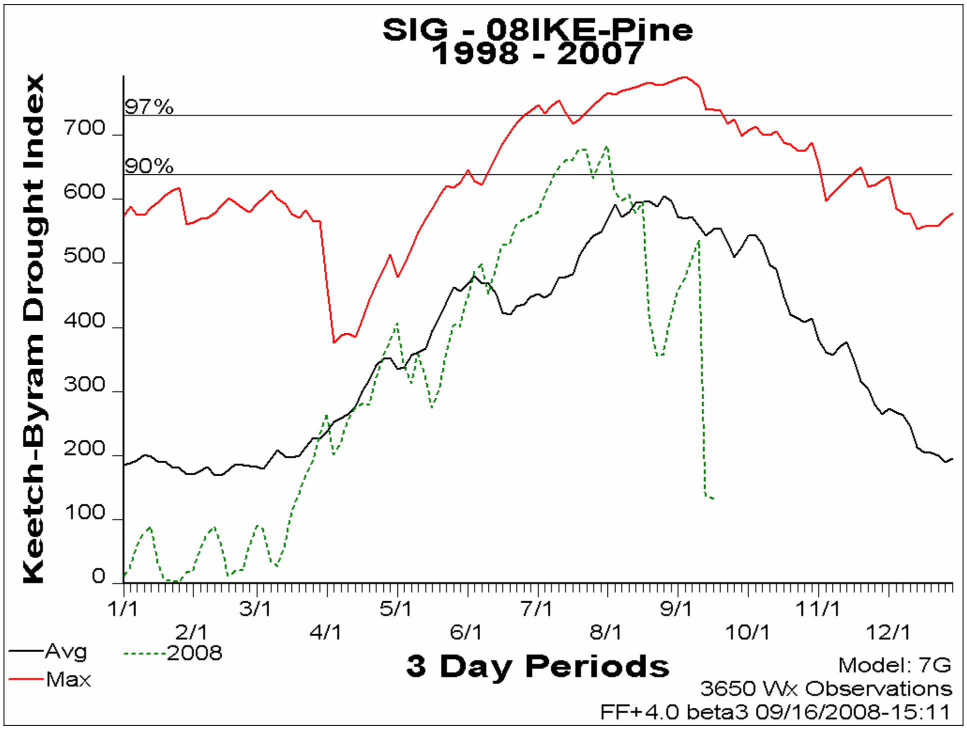
Burning Index for 2008 trended between average and extreme during the first half of the year. During the third week in August low pressure in the southern plains brought moist air onshore across the Texas coast causing flooding rains over several days. A brief drying trend was followed by shots of moisture from Hurricane's Gustav and Ike leaving the index sitting a just below average as of 9/15/08.



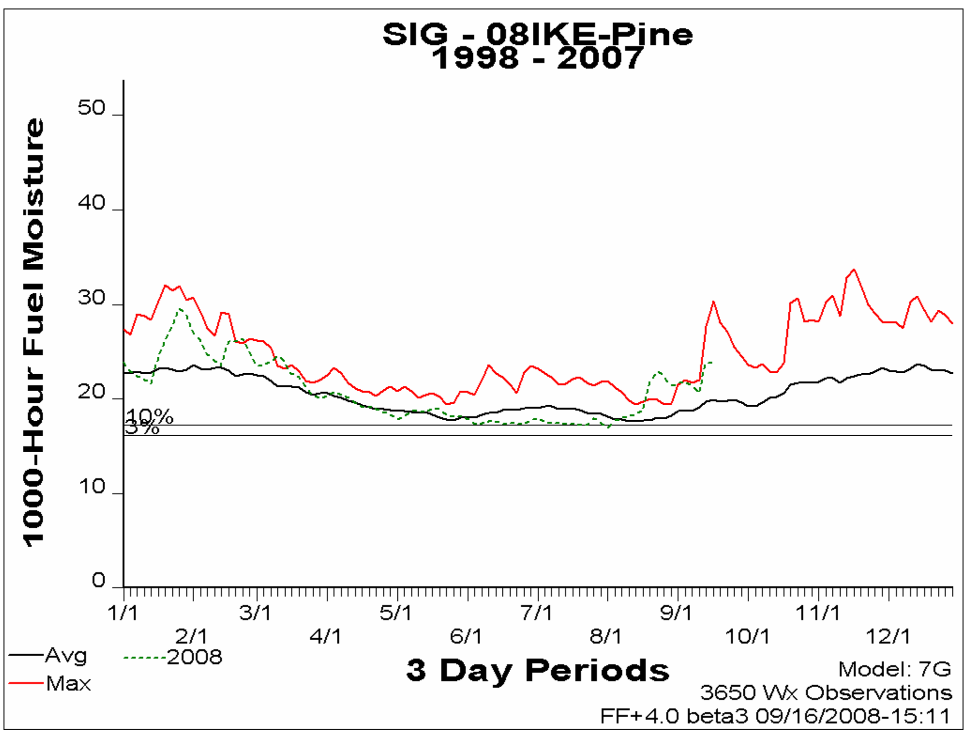
Energy Release Component followed a similar trend as BI clearly showing a drop during the third week in August with a rebound up to near average followed by a small drop with Gustav and a much larger drop with Ike, leaving the index well below average as of 9/15/08.



The Keetch-Byram Drought Index shows values peaking near critical levels near the end of July with a sharp decline into August as flooding rains raise ground moistures. The effect of Gustav is not pronounced but the effect of Ike sends values down to the lowest levels since March.



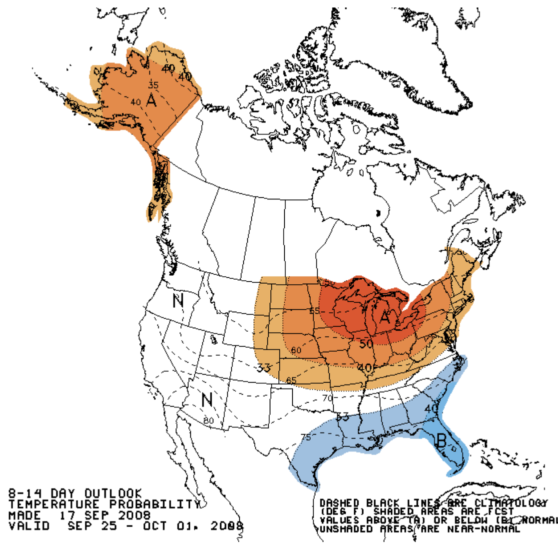
1000-Hour TLFM values have trended around average for most of the year with the trend beginning upward in August and continuing to 9/15/08 reaching the highest values of the year.

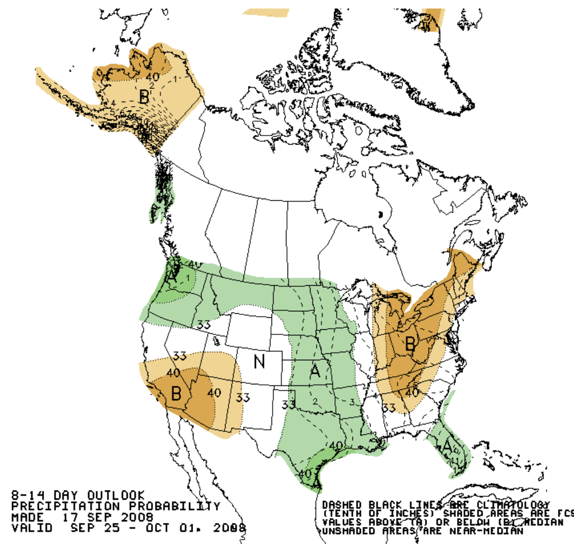


An examination of available data suggests that over the last 30 days precipitation events over the Hurricane Ike area of interest have contributed significantly to an overall reduction in short term drought impacts and fire danger. ERC and KBDI have been reduced to the lowest levels since March and 1000-Hour TLFM has increased to the highest levels of the summer season. However, year to date precipitation is shown to be below 100% of normal for an area across the Western Pineywoods and Southeast Texas PSA's. These areas may be susceptible to a rebound in fire potential over the coming weeks under the right conditions. Overall the data suggests that fire danger levels have fallen to normal to below normal in the short term

Short Term Outlook

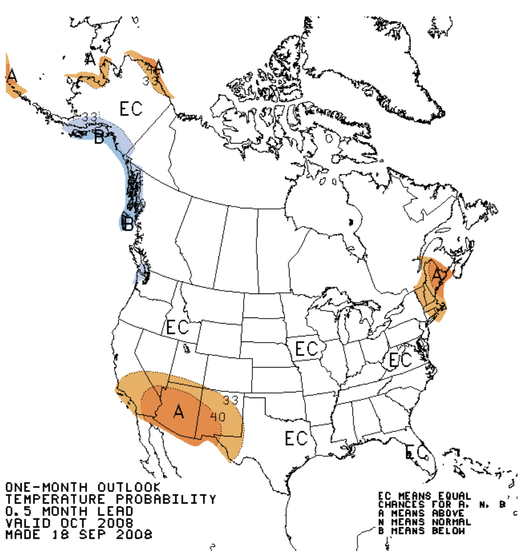
The 8-14 Day Outlook from the Climate Prediction Center for 9/17/08 forecasts below normal temperatures and above normal precipitation over east Texas through the period ending 10/1/08.

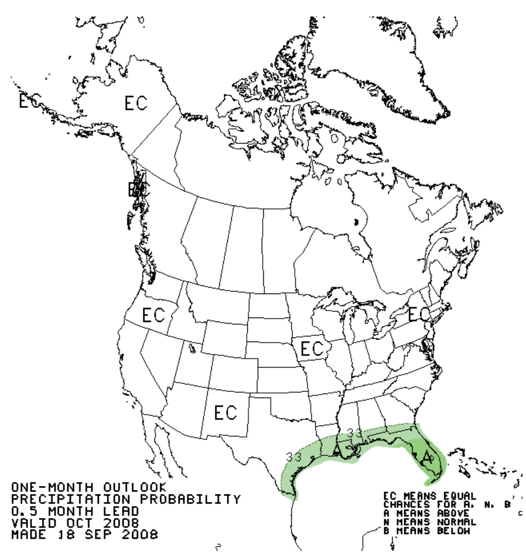


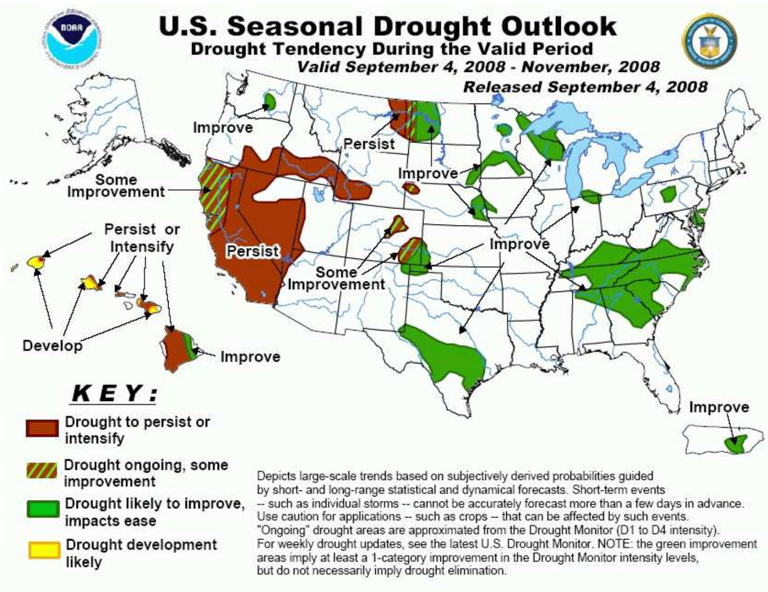


Medium Term Outlook

The Climate Prediction Center's 30 day outlook for October dated 9/18/08 calls for equal chances of normal, above normal or below normal temperature and precipitation over east Texas.



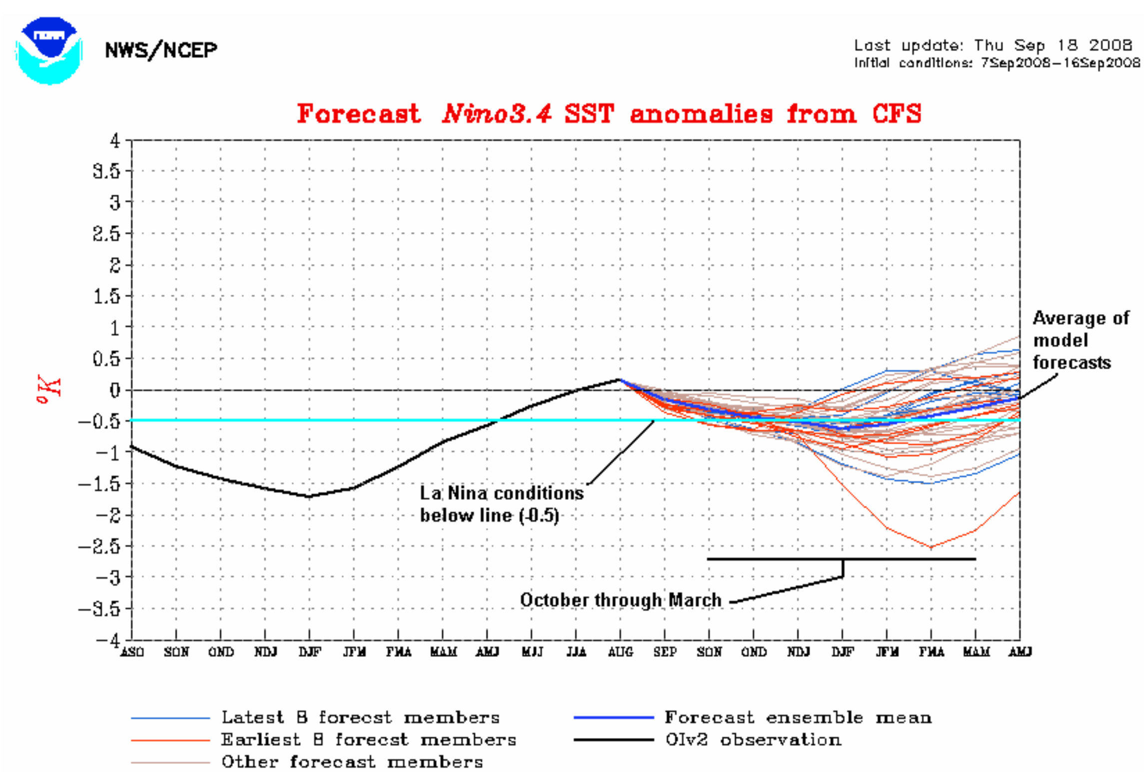




The moisture from tropical storms and other weather systems in the Southeast has boosted soil moistures and streamflows, but a few of the larger reservoirs in the interior Southeast are unlikely to recover before winter. The U.S. Seasonal Drought Outlook indicates that there will be no change in drought conditions in east Texas through the end of November.

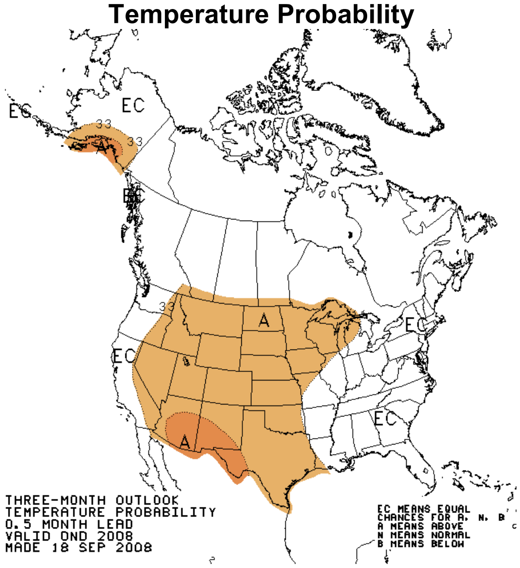
LONG TERM OUTLOOK

The Climate Prediction Center's Long Lead Seasonal Outlook dated 9/18/08 describes the current state of the tropical Pacific Ocean and atmosphere as representative of ENSO neutral conditions and is likely to remain neutral through autumn and into next year. Therefore temperature and precipitation forecasts do not use composites based on El Nino or La Nina.

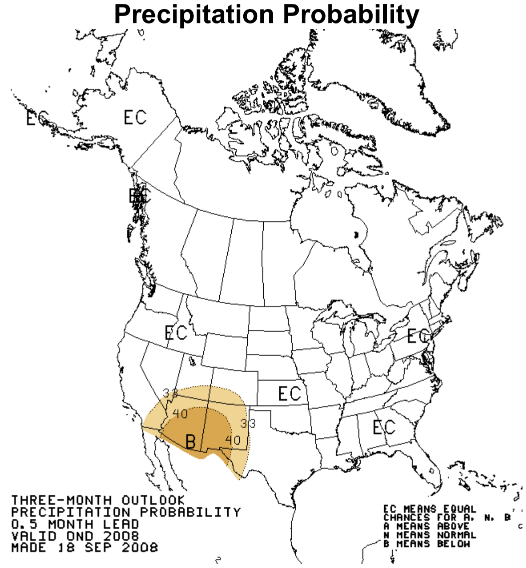


In the absence of ENSO influences, forecasts for precipitation and temperatures are based primarily on historical trends. The area of enhanced chances of above normal temperatures include most of the U.S except for the far west of the Rocky Mountains for the November, December, January 2008-2009 through January, February, March 2009 seasons. Areas of below median precipitation are forecasted for parts of the Desert Southwest from October, November, December 2008 to December, January, February, March 2008-2009 and for much of the Southeast from November, December, January 2008-2009 to March, April, May 2009 resulting from recent predictable precipitation trends.

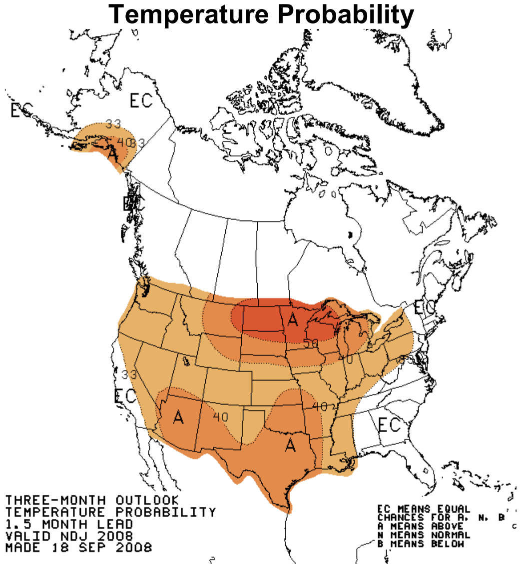
October, November, December 2008
Temperature Probability



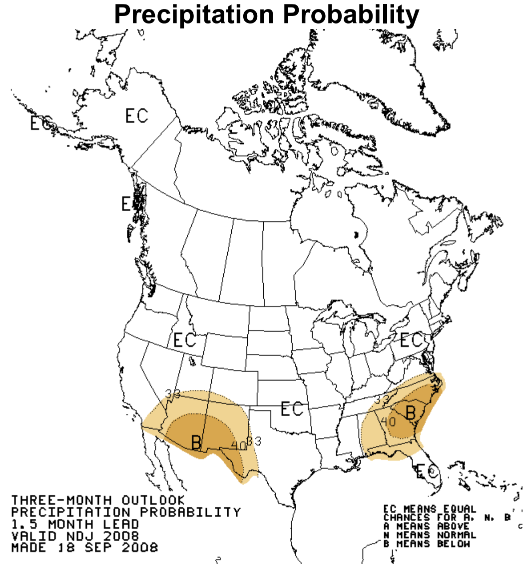
October, November, December 2008
Precipitation Probability



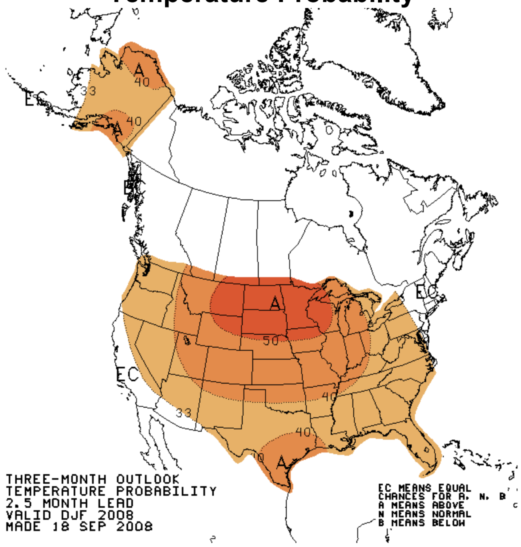
November, December, January 2008 – 2009
Temperature Probability



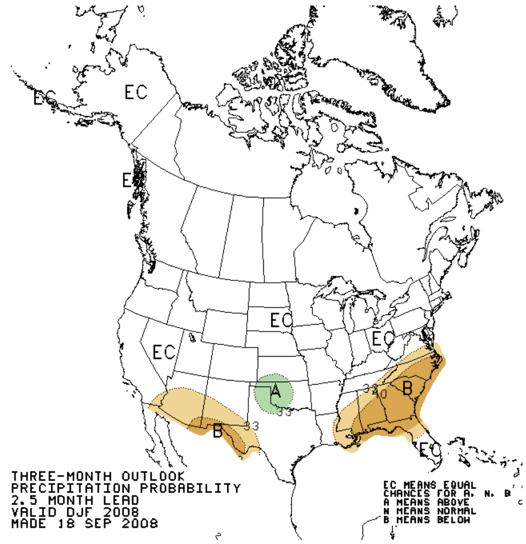
November, December, January 2008 – 2009
Precipitation Probability



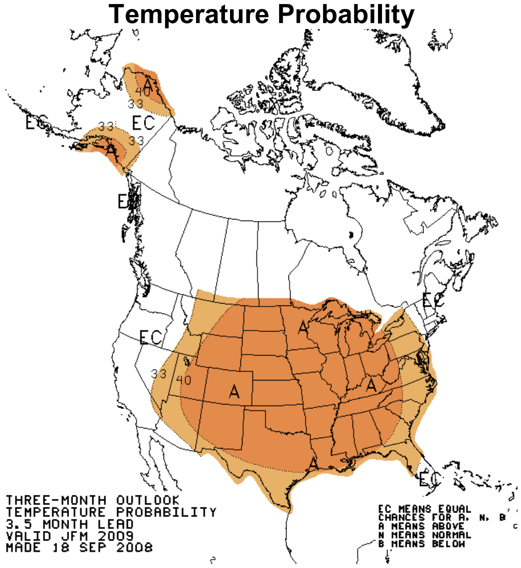
December, January, February 2008 – 2009 Temperature Probability



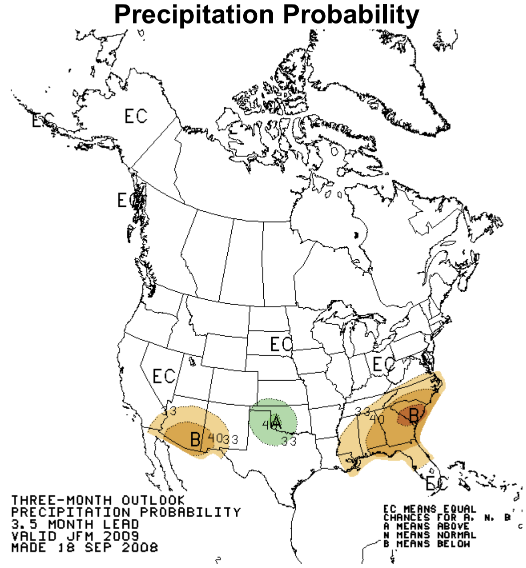
December, January, February 2008 – 2009 Precipitation Probability



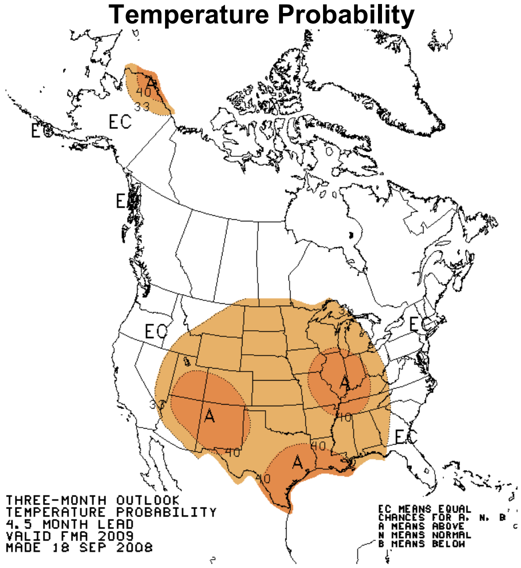
January, February, March 2009 Temperature Probability



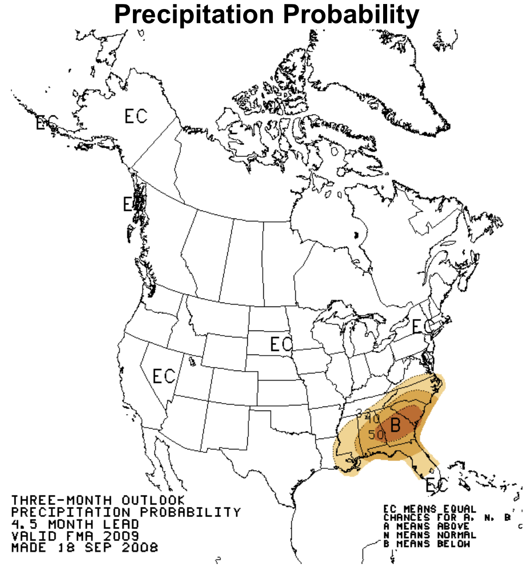
January, February, March 2009 Precipitation Probability



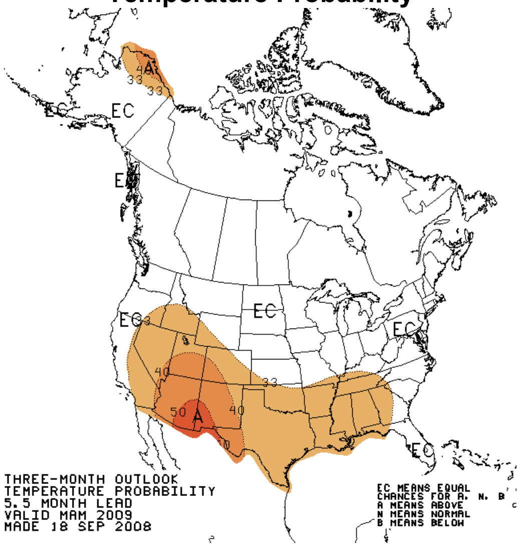
February, March, April 2009 Temperature Probability



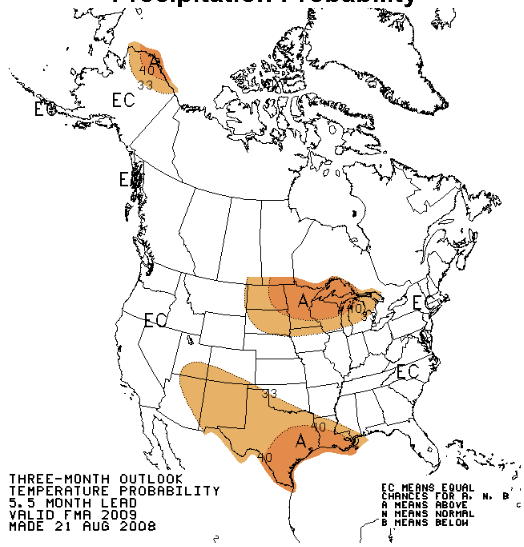
February, March, April 2009 Precipitation Probability



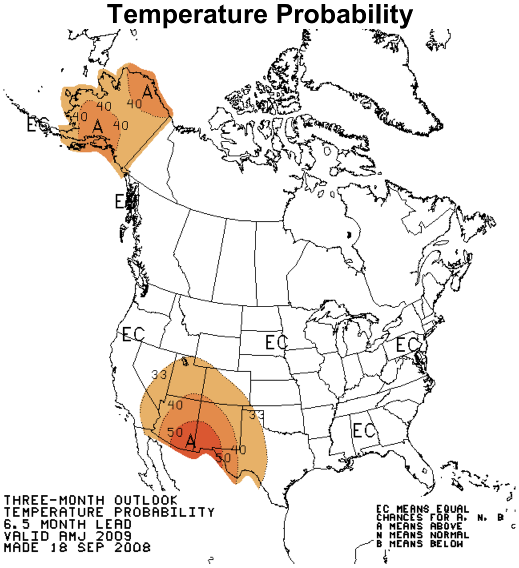
March, April, May 2009
Temperature Probability



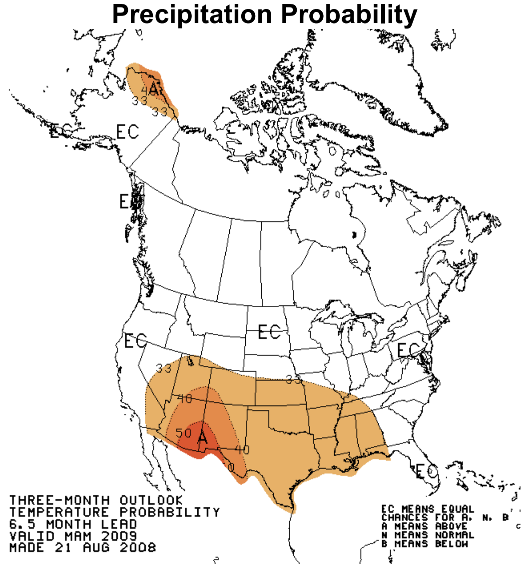
March, April, May 2009
Precipitation Probability



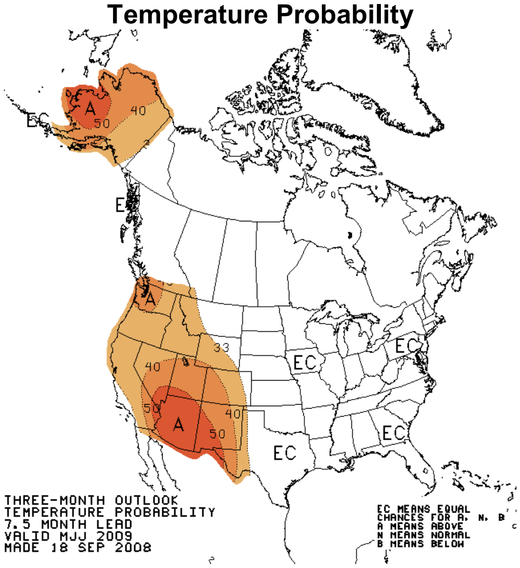
April, May, June 2009
Temperature Probability



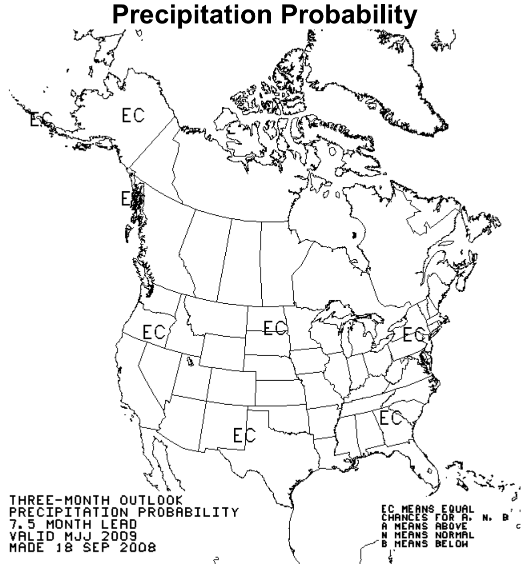
April, May, June 2009
Precipitation Probability



May, June, July 2009
Temperature Probability



May, June, July 2009
Precipitation Probability



Conclusion

Precipitation events affected the Hurricane Ike area of interest significantly over the last 30 days. Flooding rains during the last part of August and Hurricanes Gustav and Ike provided sufficient moisture to ameliorate the impacts of short term drought and reduce fire danger potential across east and southeast Texas with the possible exception of areas in the Western Pineywoods and Southeast Texas PSA's. Fire danger levels currently stand at normal to below normal across the area.

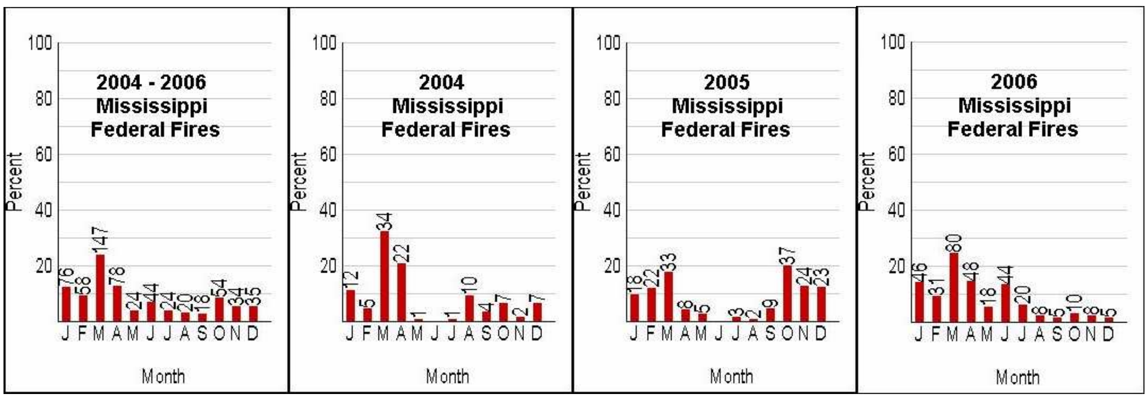
The current Climate Prediction Center 8 to 14 day forecast indicates a high probability for above normal moisture and below normal temperatures over the area of interest through the forecast period valid until 10/1/08. The 30 day forecast for October calls for a higher probability of above normal precipitation along the Texas coast but and equal chances of normal, above normal or below normal temperature and precipitation over the rest of Texas. The U.S. Drought Monitor valid through the end of November indicates neutrality in the drought condition throughout the area as well.

The Climate Prediction Centers Long Lead Outlook indicates a higher probability of above normal temperatures throughout the area of interest through the fall over the winter and into the spring through April and equal chances of above, below or normal precipitation until March and then a higher probability of below normal precipitation beginning in April and May.

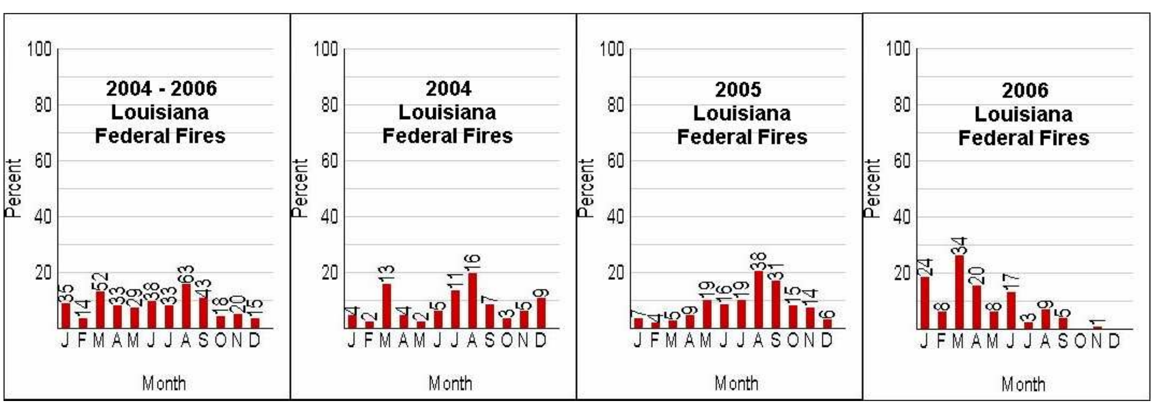
In looking at the short, medium and long range outlook for fire danger potential the most critical factor will be a higher probability of higher than normal temperatures over the "cured season". Above normal precipitation forecasted over the next 8-14 days on top of moisture surpluses gained over the last 30 days may be sufficient to provide a buffer against fire potential over the medium term (1-2 months).

FIRE OCCURRENCE

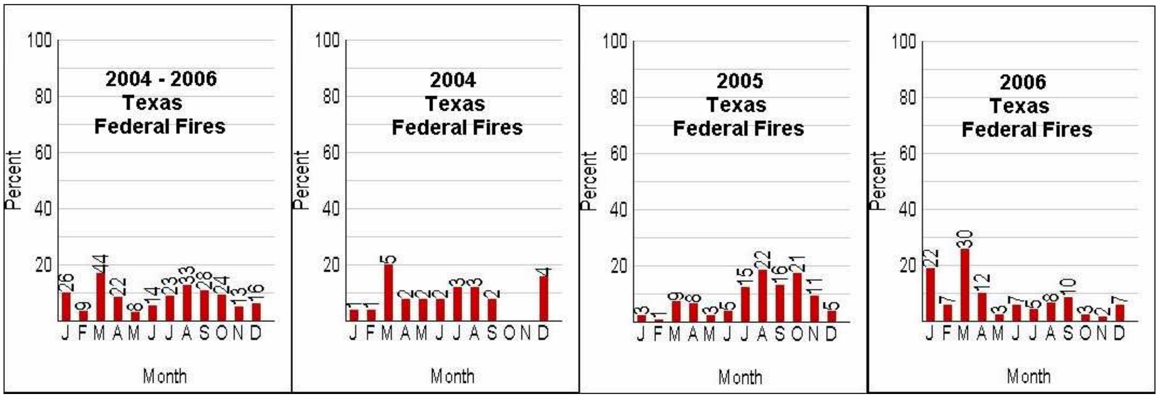
The following graphs show fire occurrence on federal lands in Mississippi, Louisiana and Texas for the years 2004 – 2006 as a comparison of fire occurrence before and after hurricanes Katrina and Rita. The first series of graphs are for federal fires in Mississippi. The first graph shows the 3 year trend for 2004 – 2006. Number are up in January, February, March (JFM) with the maximum in March and up again in October, November, December (OND) with a maximum in October. In the graph for 2004, numbers for OMD are low but in the graph for 2005 numbers for OMD are much higher. OMD for 2005 was post Katrina and Rita. In the graph for 2005, numbers for JFM are 18, 22 and 33 respectively. In the graph for 2006, the numbers for JFM are 46, 31 and 80 respectively, the trend holds for JFM from 2005 to 2006 but the numbers in 2006 are up significantly. These comparisons suggest that after hurricane's Katrina and Rita that there was an increase in the numbers of fires on federal lands in Mississippi during the months of October, November, December 2005 and January, February, March 2006.



The next series of graphs are for federal fires in Louisiana. The first graph shows the 3 year trend for 2004 – 2006. Numbers are up in January and March with the maximum in March and up again in August and September with a maximum in August. Katrina occurred in late August 2005 and Rita occurred within 2 weeks of Katrina. In the graph for 2005 the numbers for August, September, October and November are up over the same period in 2004 and 2006. In the graph for 2006, numbers for January, February, March are up over the same period in 2004 and 2005 with January and March 2006 up significantly.



The final series of graphs are for federal fire in Texas. The first graph shows the 3 year trend for 2004 – 2006 and is similar to the series for Louisiana. Number are up in January and March with the maximum in March and up again in August and September with a maximum in August. In the graph for 2005 the numbers for August, September, October, November are up over the same period in 2004 and 2006. In the graph for 2006, numbers for January, February, March are up over the same period in 2004 and 2005 with January and March up significantly.



This brief analysis of fire occurrence is by no means conclusive. It does suggest that in the months immediately following hurricanes Katrina and Rita and for several months afterward there was an increase in fire occurrence on federal lands in Mississippi, Louisiana and Texas. It does not prove a correlation however. The majority of wildfire ignitions in all three states historically are human caused so it can be inferred that there were increases in human caused fires during the period. The analysis only looks at fires on National Forest and U.S. Fish and Wildlife lands. The FireFamily Plus database that was used for the analysis was provided by Southern Area Coordination Center Predictive Services and only included fire occurrence on state and private lands through 2004. Fire occurrence on federal lands in the Southern Area accounts for only a small percentage of overall fire occurrence in the Southern area and thus without conducting a more thorough analysis of the same type including all available and up to data for fire occurrence on state and private lands this analysis should be considered an exercise.

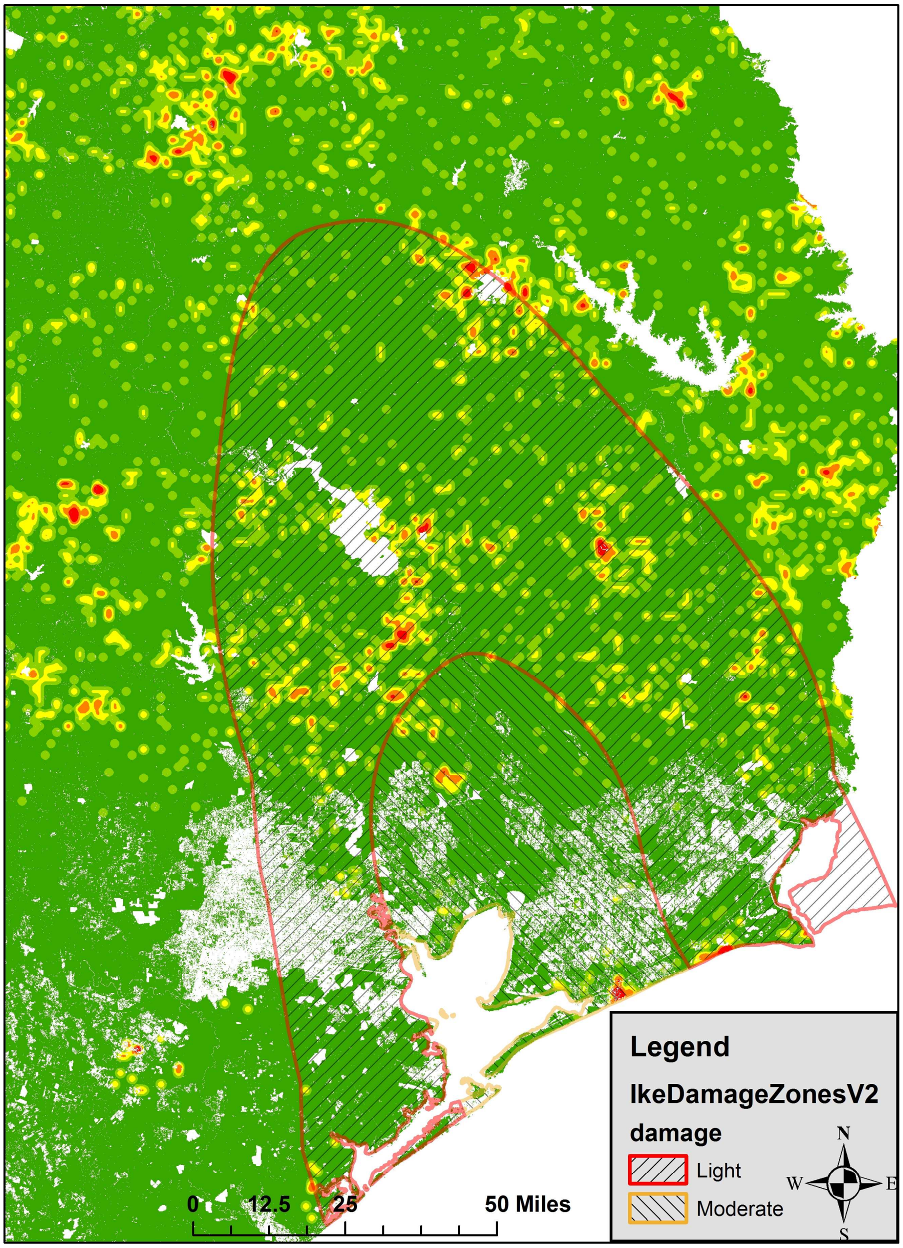
Fire on the Texas Landscape

Historical fire occurrence in this area of Texas is depicted on the following map. Areas where a high number of fires have occurred historically appear in red on the map with moderate areas appearing in yellow, and low occurrence areas in green. In the months and years to come these historical trends will likely continue with areas currently displayed as having high fire occurrence continuing to have high fire occurrence. As noted above, fire occurrence, even in areas with historically low occurrence, may show an increase over the next several months as a result of debris burning by private landowners.

High density fire nodes within the moderate damage zone should be considered for priority fuels treatments to lower the risk of wildfires occurring in the post-Ike fuel bed which would be harder and costlier to contain than prior to Ike.

Areas in the light damage zone, near high fire occurrence nodes that have been identified in FlamMap as being higher potential for increased fire behavior should also be considered for priority fuel reduction treatments.

Texas State and Federal Fire Ocurrance



MANAGEMENT IMPLICATIONS

The task set before all wildland fire managers is to evaluate the current and anticipated wildland fire risk, and to respond appropriately considering cost/benefit as conditions change temporally. Vegetation/fuel changes can be gradual taking many years or they can be immediate resulting from natural phenomena like tornados, volcanic eruptions, or hurricanes. The degree of change and the required management response depends on how much change has occurred. Hurricane Ike damage assessments from the field indicate widespread moderate damage from the coast inland for up to 65 miles with the majority of moderate damage confined to the bottomland hardwoods and coastal marshes. Bottomland hardwoods have not historically contributed to wildfire risk except during periods of severe drought. Deposition of debris and effects of inundation with salt water will change the fire behavior and management tactics in the coastal marshes. Light damage in the more inland pine stands will contribute to an increase in potential fire behavior in these areas. In light of these findings the following recommendations become applicable to those localized areas where additional fuel loadings will alter fire behavior characteristics. The changes resulting from Hurricane Ike will require that we alter our wildland fire management response. More importantly, there is the safety concern to fire suppression personnel if we do not alter our management strategy.

MANAGEMENT RECOMMENDATIONS TABLE

Management Action	***Damage Severity*** **Scattered Light**	***Damage Severity (in addition to actions in the "scattered light" category)*** **Light / Moderate**
SAFETY	• Provide a thorough inventory and analysis of existing fuel loading (ground/aerial). • Identify specific safety concerns (i.e. known hazards and risks) with mitigation measures utilizing the Job Hazard Analysis (JHA) process. • Hold tailgate safety sessions daily specifically addressing the high risks and hazards relating to the new fuel loading (i.e. blow-down, widow-makers; learners, jackpots, etc. • Consider Safety Officer(s) on site of treatment area(s).	• Identify hazards associated with prescribed fire or suppression efforts in coastal marshes impacted by industrial and housing debris. • Blocked access into and out of fire areas may compromise the safety of firefighter/prescribed fire personnel. Additional saws will be required **or** tactics adjusted to take advantage of nearby roads and natural barriers.

MANAGEMENT RECOMMENDATIONS TABLE		
Management Action	***Damage Severity*** **Scattered Light**	***Damage Severity (in addition to actions in the "scattered light" category)*** **Light / Moderate**
	• Provide specific risks and hazards PRIOR to days work. • Consider logging equipment for fuel removal, brush management, and opening the forest canopy if exposure to employees is too great. • Consider contracting out professional fallers.	
PREVENTION	• Implement FIREWISE program	• When fire indices reach high/extreme, order Prevention Teams for coordination and expertise • Increase patrols on high and extreme fire danger days • Designate debris disposal sights for public burning • Educate Public on safe burning techniques (Consider grants to support public education, consider using the "Give us a Year" program South Carolina employed after Hurricane Hugo) • Reevaluate fire restriction, burn bans and burn permit guidelines • Consider briefing County Administrators and Judges on the importance of burn bans during times of High / Extreme Fire Danger. • Evaluate and adjust Fire Detection Plans with cooperators
PREPAREDNESS	• Fire Behavior runs modeled in LIGHT damaged cover types showed no difference between PRE and POST Hurricane.	• Wildland Fire Training should be revised to address the increased flame lengths associated with light and moderate damaged areas [i.e. LCES, Strategy and Tactics (direct vs. indirect), Trigger Points, mop-up standards] • Increase pool of Type 3 and 4 IC's, complex burn bosses, aviation overhead and certified fallers to manage a more complex landscape. • Directing helicopter bucket drops, using indirect suppression tactics and using sawyers out in front of dozers need to be addressed and discussed prior to fire season with all fire

MANAGEMENT RECOMMENDATIONS TABLE		
Management Action	***Damage Severity*** **<u>Scattered Light</u>**	***Damage Severity (in addition to actions in the "scattered light" category)*** **<u>Light</u> / <u>Moderate</u>**
PREPAREDNESS, cont.		personnel. • When fire indices reach high/extreme, evaluate need to preposition tactical fire suppression resources (ground and / or aviation) based on fire indices (i.e. *GROUND*-ICT3 led Task Force of Engines, Dozers and Crews. *AIR*- Type 1 Helicopters) • Update flight hazard maps • Consider developing additional land use agreements for helicopter dip sight operations. • Update Community Wildfire Protection Plans to reflect changed fuel conditions • Identify and prioritize the need for mechanical treatments based on values at risk • Discuss management strategies for dealing with Peat Bog Fires with Line Officers • Update Safety Briefings to include new hazards associated with these changed fuels conditions (i.e. snags, weakened trees, fire behavior) • Update Fire Pre Suppression Plans • Implement identified changes in Fire Detection Program • Gather fuels data and update GIS layers to incorporate changed conditions-consider cumulative effects from past hurricane damage. • Consider implementing Strategic Placement Of Treatments (SPOTS) fire modeling as a planning method • Update smoke monitoring plans to reflect fuel loading changes • Integrate the impacts on carbon storage sequestration in short and long-term management plans

MANAGEMENT RECOMMENDATIONS TABLE		
Management Action	***Damage Severity*** **<u>Scattered Light</u>**	***Damage Severity (in addition to actions in the "scattered light" category)*** **<u>Light</u> / <u>Moderate</u>**
FUELS TREATMENTS	• Implement priority projects for mechanical treatments based on values at risk. (i.e. thinning, hand piling, chipping, mulching, wind rowing, crushing, mulching) • Improve fuel breaks around burn units where necessary to meet control objectives	• Utilize salvage logging to: offset costs, reduce heavy fuel loading and decrease residual smoke impacts during RX treatments • RX plans need to be amended to account for increased fuel loads (i.e. pre treatment, overstory mortality, smoke outputs, hazards, resource needs, fire effects, mop up standards, etc.) • Adjust prescribed fire program based on: 1) delays caused by mechanical pre-treatment 2) narrower burn windows due to the increase in potential for overstory mortality or other unwanted fire effects • Inform public of potential increase in smoke production from prescribed fire and wildfire. Consider utilizing incinerators around smoke sensitive areas. • Track additional costs per / acre to implement prescribed fire fuel treatments and adjust budget requests • Consider establishing a program to aid private land owners in fuel reduction projects (Mississippi did this post Hurricane Katrina)
SUPPRESSION	• Use Appropriate Management Response (Right Resource, Right Time, Right Place) • Ensure Safety Briefings address new hazards (i.e. snags, weakened trees, increased fire behavior, hanging limbs)	• Access to fires and for handcrews and motorized equipment may be limited and/or unsafe in areas of heavy blowdown. Consider indirect attack from nearby roads or utilizing natural barriers. • Ensure resources can hold control line before control line is put in (i.e. don't put in a control line you can't hold) • Expect Multiple start scenarios to begin at MODERATE fire danger days • Validate Incident Complexity in these areas (i.e. Type 5 fires in pre hurricane conditions may now be Type 4) • Utilize ICT3 led Taskforces (Engines, Dozers, Crews) during times of high / extreme fire danger • Consider utilizing Type 1 Helicopters and Heavy Air Tankers • Account for decreased line production rates, spotting and mop up in developing suppression tactics

MANAGEMENT RECOMMENDATIONS TABLE		
Management Action	***Damage Severity*** **Scattered Light**	***Damage Severity (in addition to actions in the "scattered light" category)*** **Light / Moderate**
MONITORING	• Increase monitoring of insects and diseases as these contribute to wildfire hazards	• Assess the need for additional fire effects monitoring on RX projects to ensure treatment objectives are being met (burning in areas with uncharacteristic fuel loads may have negative impacts on resource values). • Consider utilizing Research community to study fire behavior in these changed fuel types and vegetative communities (i.e. fire behavior in Bottomland Hardwood Swamps)

CONCLUSION

This wildland fire hazard assessment broke new ground in several aspects of post-hurricane fuel analysis in the Southern Area Geographic Region. Processes used in previous post-hurricane assessments were integrated and updated to take advantage of emerging technologies and tools; specifically, the process used in this assessment is spatially explicit and allows managers and decision-makers to identify the location and extent of post-hurricane changes in fuels and potential fire behavior.

The assessment also provides managers with recommendations for future management actions in the safety, prevention, preparedness, suppression and fuel management programs to mitigate hazards associated with these changes in fuel characteristics in the areas affected by Hurricane Ike.

The analysis of post-hurricane changes in fuel conditions found three general areas of concern. The coastal marshes will experience an increase in dead fuel load as salt water inundation causes greater mortality; in combination with deposition of debris from hurricane-damaged infrastructure, the nature and effects of fire in these areas may be altered and require different management strategies. The bottomland hardwood vegetation cover type has traditionally served as a barrier to wildfire growth except under severe drought conditions, but the potential for uncharacteristic fire behavior and effects as well as the firefighter safety aspects of changes in fire behavior in this vegetation cover type bears additional research and monitoring efforts. The managed and more open pine forest stands farther from the coast were subject to greater damage and subsequent greater increases in fuel loading than denser stands, and may see a greater increase in fireline intensity.

The analysis also depicts on a map the locations of areas where the potential fire behavior has increased in intensity to the degree that may require a change in fire suppression tactics. This information is useful at several levels, from briefing suppression crews to programmatic decision-making and resource allocation.

RECOMMENDATIONS FOR FUTURE ASSESSMENTS

- Spatial analysis of risk/damage takes much more time than hurricane assessments completed in the past. Thought should be given to conducting these assessments at a location with a GIS computer lab that can process the large amounts of data in hurricane-size landscapes more quickly than the portable computers typically utilized by fire management personnel.

- In the first several days after a hurricane makes landfall, there is very little local knowledge that can be obtained to assist in the assessment. Preliminary impact assessments often take several days after landfall to become reliable. Spatial assessments could begin two or more days after landfall, and up to a week may be necessary to complete the assessment after the team has been assembled.

- Feedback is critical to perfecting assessment techniques as we begin to utilize new spatial analysis tools. When an assessment provides management recommendations, these should later be validated from the field as to their effectiveness; the validation can then help to adapt future assessment into a worthwhile tool for managers making fire management decisions.

- Remote sensing tools should be sought out which would help to evaluate vegetation change after disturbance which could help assessment teams to validate fuel model changes.

- Because the SWRA is an important component of fire management in the southern region, fuels layers should be updated within this system when assessments are completed in the future. Consideration should be given to co-locating the individual responsible for updates to the SWRA with the assessment team so that they can take advantage of fuels expertise within the assessment team.

- As damage assessments move into the spatial realm, thought should be given to evaluating other landscape impacts such as smoke production change, carbon sequestration effects, and the cumulative effects of multiple hurricanes impacting the same area over a number of years.

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APPENDICES

APPENDIX A: Enlarged Maps and Images

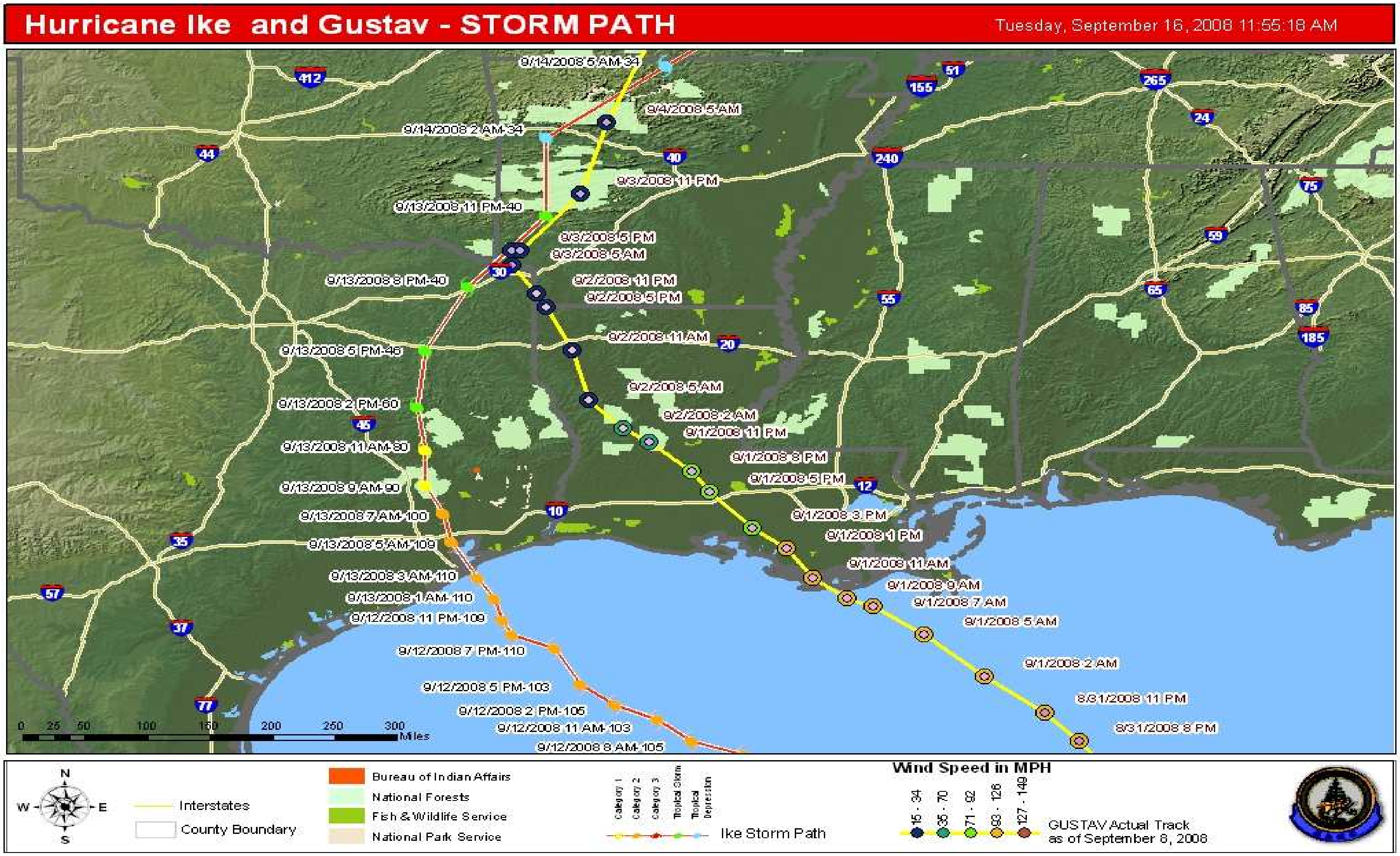
APPENDIX B: Wildland Fire Hazard Assessment for Land Between the Lakes NRA

APPENDIX C: Scott & Burgan Standard Fuel Models for Fire Behavior Prediction: Fuel Models Used in Hurricane Ike Wildland Fire Hazard Assessment

APPENDIX D: NEXUS Fire Behavior Outputs for Four Percentile Weather Classes

APPENDIX E: Assessment Group Contact Information

APPENDIX A: Enlarged Maps and Images



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9/13/2008 11 PM-40
9/13/2008 8 PM-40
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9/13/2008 11 AM-80
9/13/2008 9 AM-90
9/13/2008 7 AM-100
9/13/2008 5 AM-109
9/13/2008 3 AM-110
9/13/2008 1 AM-110
9/12/2008 11 PM-109
9/12/2008 7 PM-110
9/12/2008 5 PM-103
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9/12/2008 11 AM-103
9/12/2008 8 AM-105
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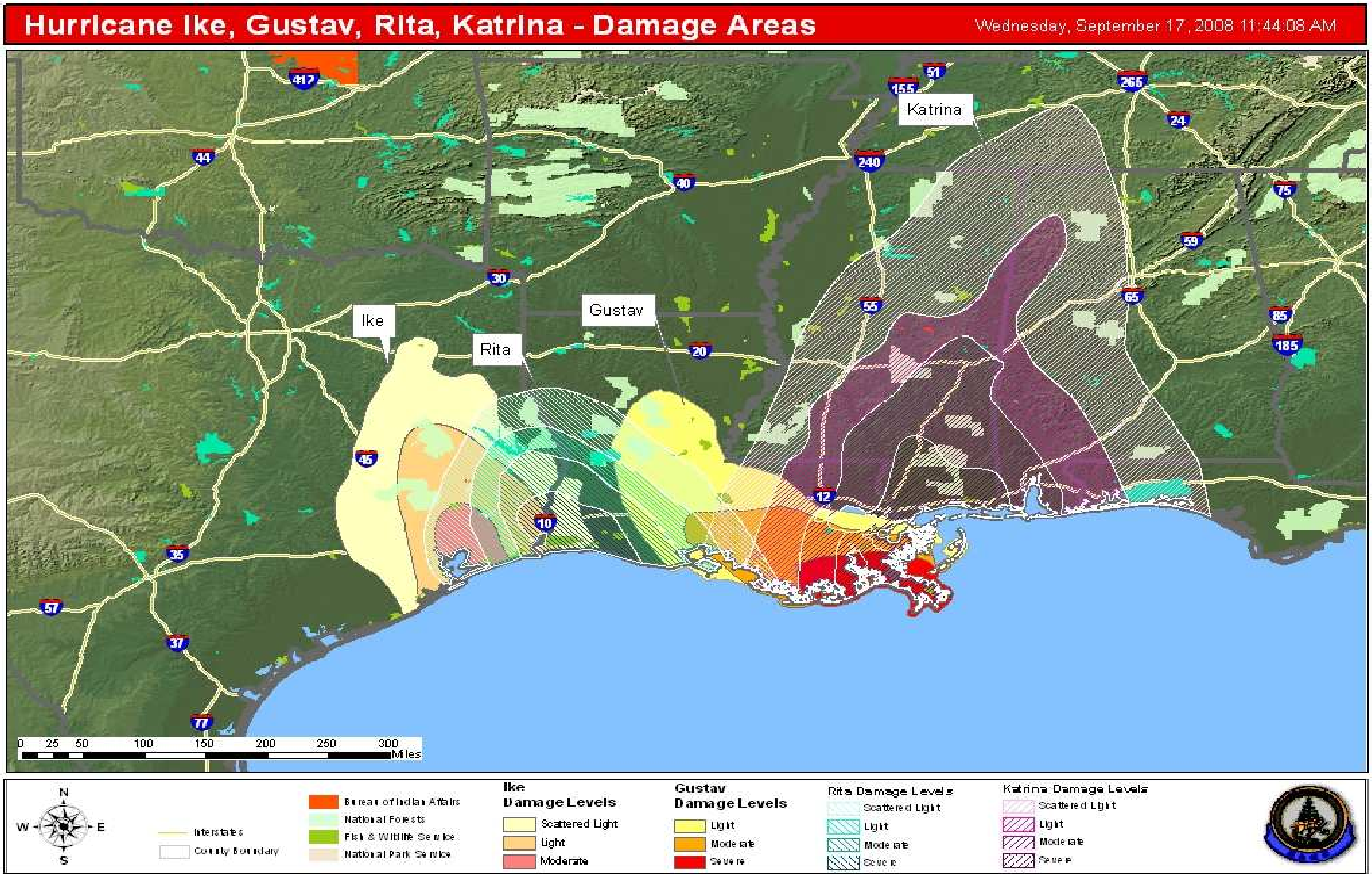
9/1/2008 5 AM
9/1/2008 2 AM
8/31/2008 11 PM
8/31/2008 8 PM
0 25 50 100 150 200 250 300 Miles
N
W
E
S
Interstates
County Boundary
Bureau of Indian Affairs
National Forests
Fish & Wildlife Service
National Park Service
Category 1
Category 2
Category 3
Tropical Storm
Tropical Depression
Ike Storm Path
Wind Speed in MPH
15 - 34
35 - 70
71 - 92
93 - 126
127 - 149
GUSTAV Actual Track
as of September 8, 2008


Hurricane Ike, Gustav, Rita, Katrina - Damage Areas
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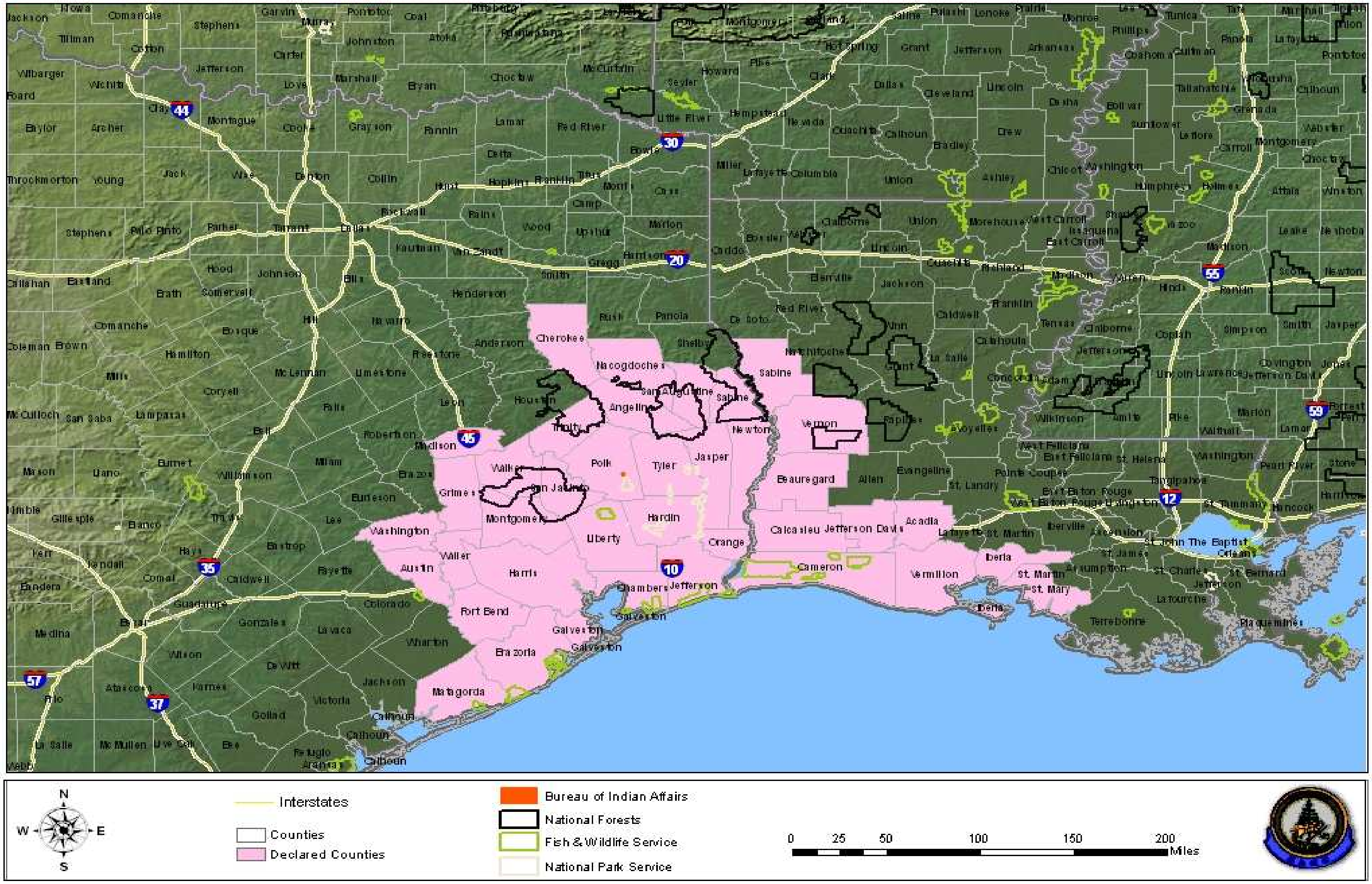
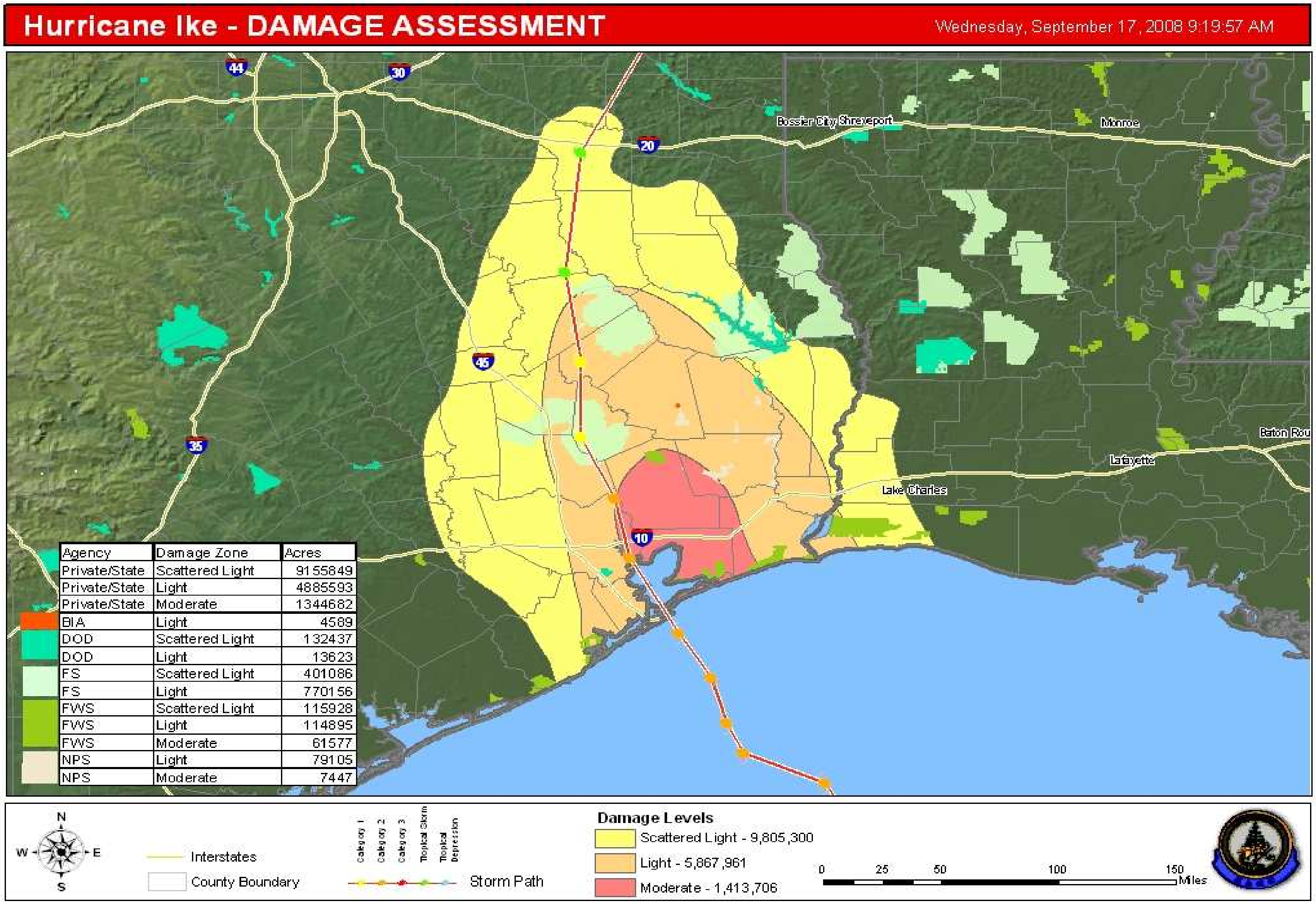
Katrina
Ike
Rita
Gustav
0 25 50 100 150 200 250 300 Miles
N
W
E
S
Interstates
County Boundary
Bureau of Indian Affairs
National Forests
Fish & Wildlife Service
National Park Service
Ike Damage Levels
Scattered Light
Light
Moderate
Gustav Damage Levels
Light
Moderate
Severe
Rita Damage Levels
Scattered Light
Light
Moderate
Severe
Katrina Damage Levels
Scattered Light
Light
Moderate
Severe

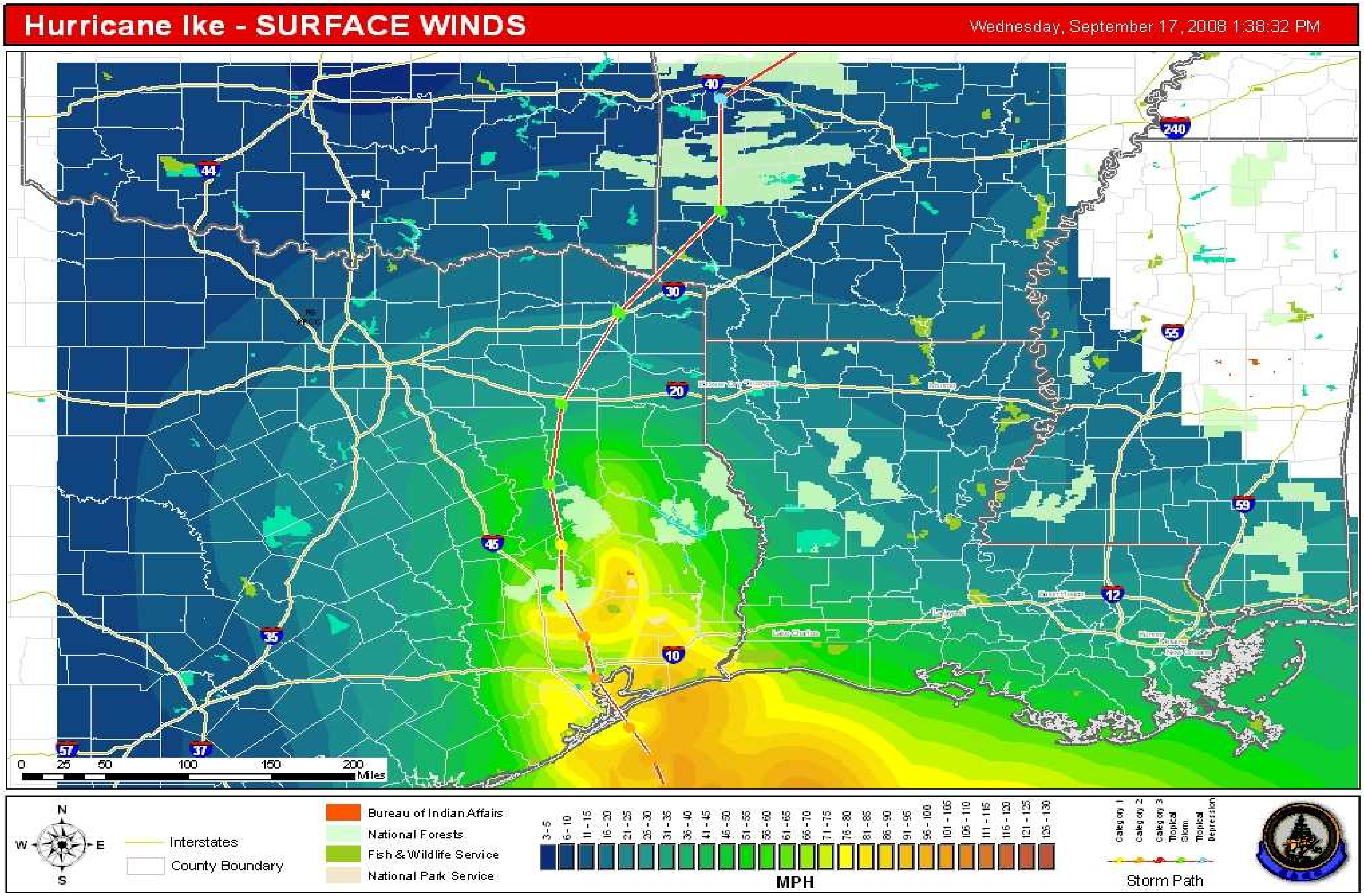
Hurricane Ike Federally Declared Disaster Areas

Tuesday, September 16, 2008 3:11:49 PM





Agency	Damage Zone	Acres
Private/State	Scattered Light	9155849
Private/State	Light	4885593
Private/State	Moderate	1344682
BIA	Light	4589
DOD	Scattered Light	132437
DOD	Light	13623
FS	Scattered Light	401086
FS	Light	770156
FWS	Scattered Light	115928
FWS	Light	114895
FWS	Moderate	61577
NPS	Light	79105
NPS	Moderate	7447



Hurricane Ike - SURFACE WINDS
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N
S
W
E
Interstates
County Boundary
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National Forests
Fish & Wildlife Service
National Park Service
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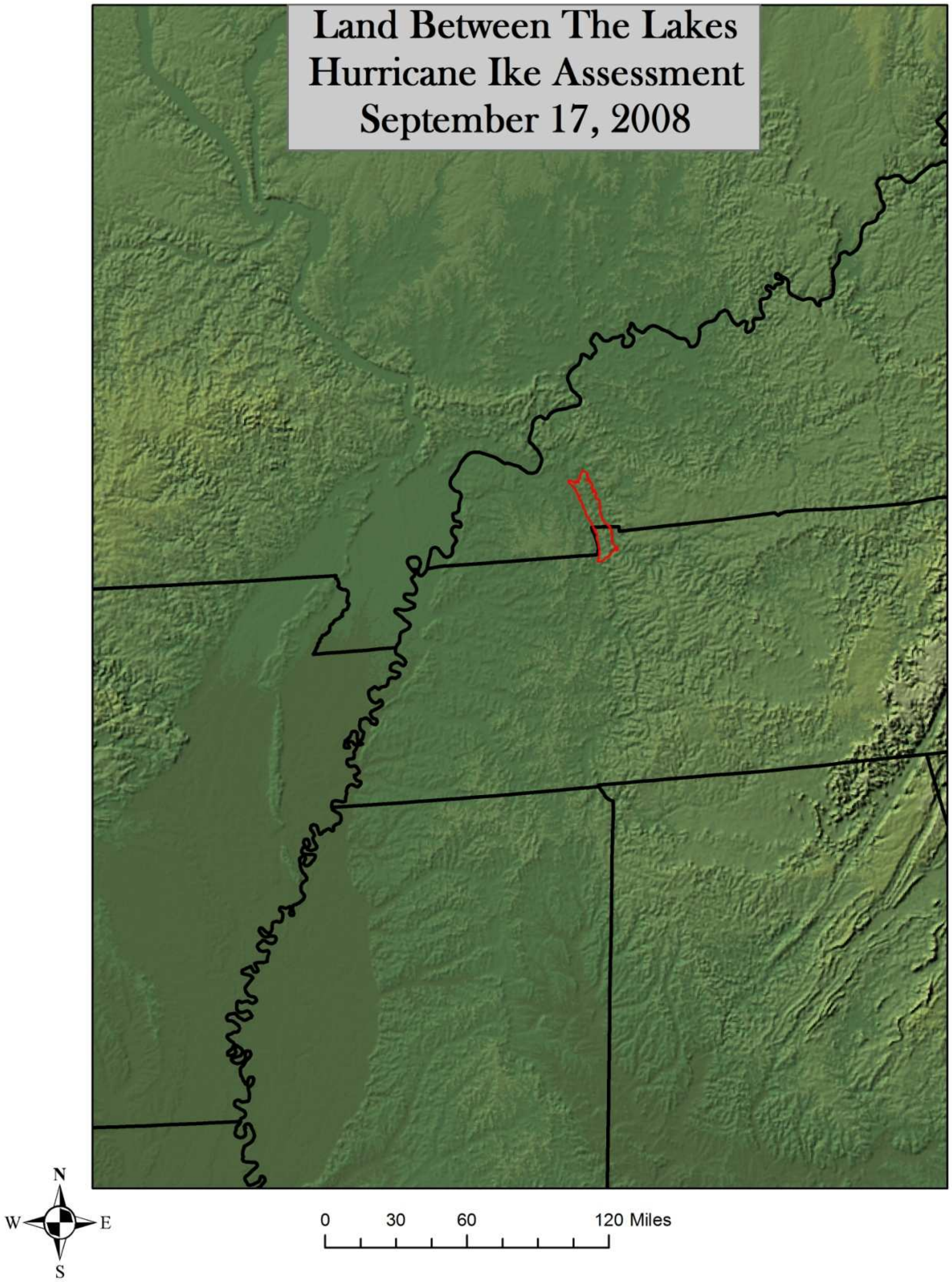
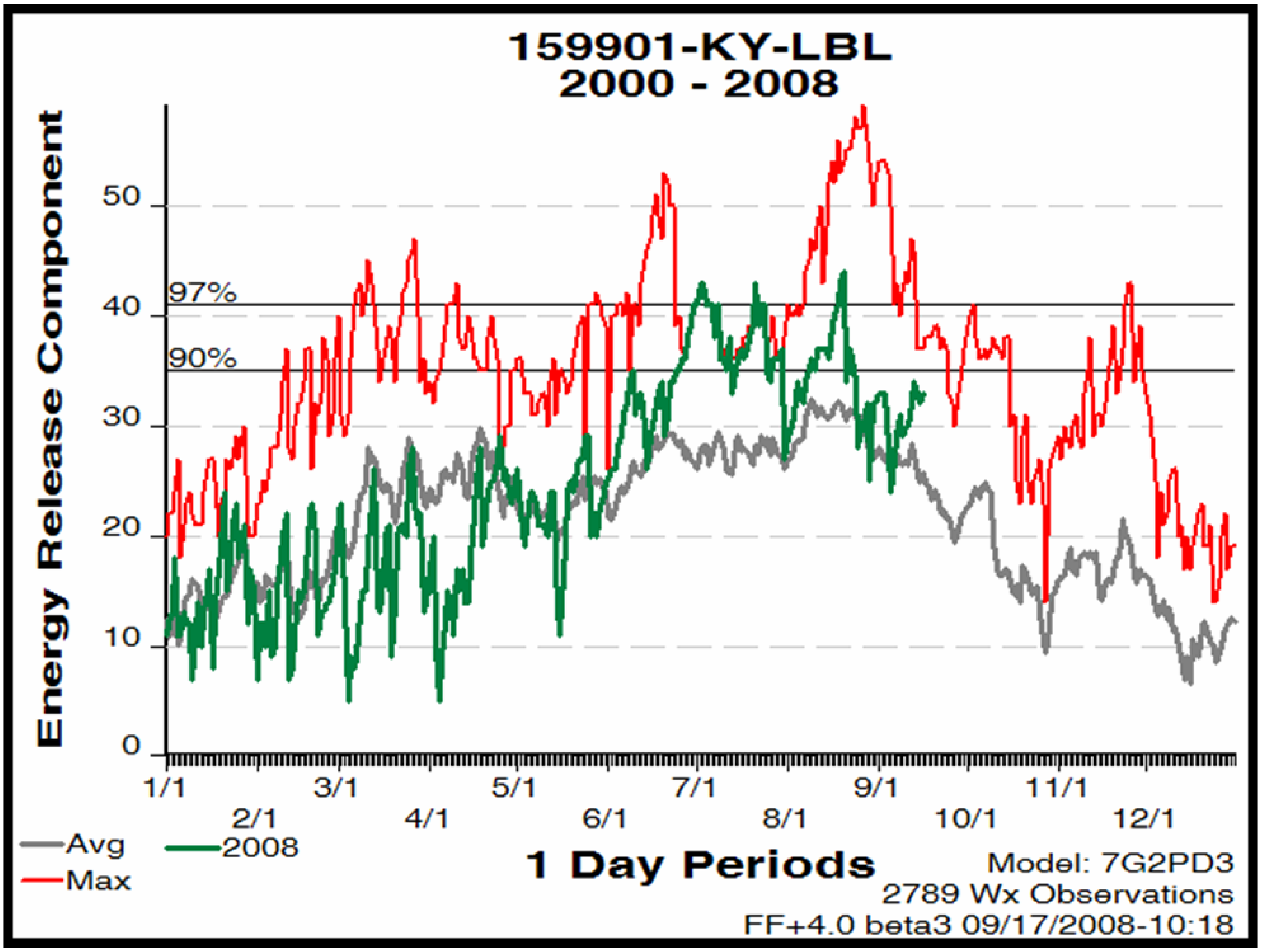
6 - 10
11 - 15
16 - 20
21 - 25
26 - 30
31 - 35
36 - 40
41 - 45
46 - 50
51 - 55
56 - 60
61 - 65
66 - 70
71 - 75
76 - 80
81 - 85
86 - 90
91 - 95
96 - 100
101 - 105
106 - 110
111 - 115
116 - 120
121 - 125
126 - 130
MPH
Category 1
Category 2
Category 3
Tropical Storm
Tropical Depression
Storm Path



Land between the Lakes National Recreation Area

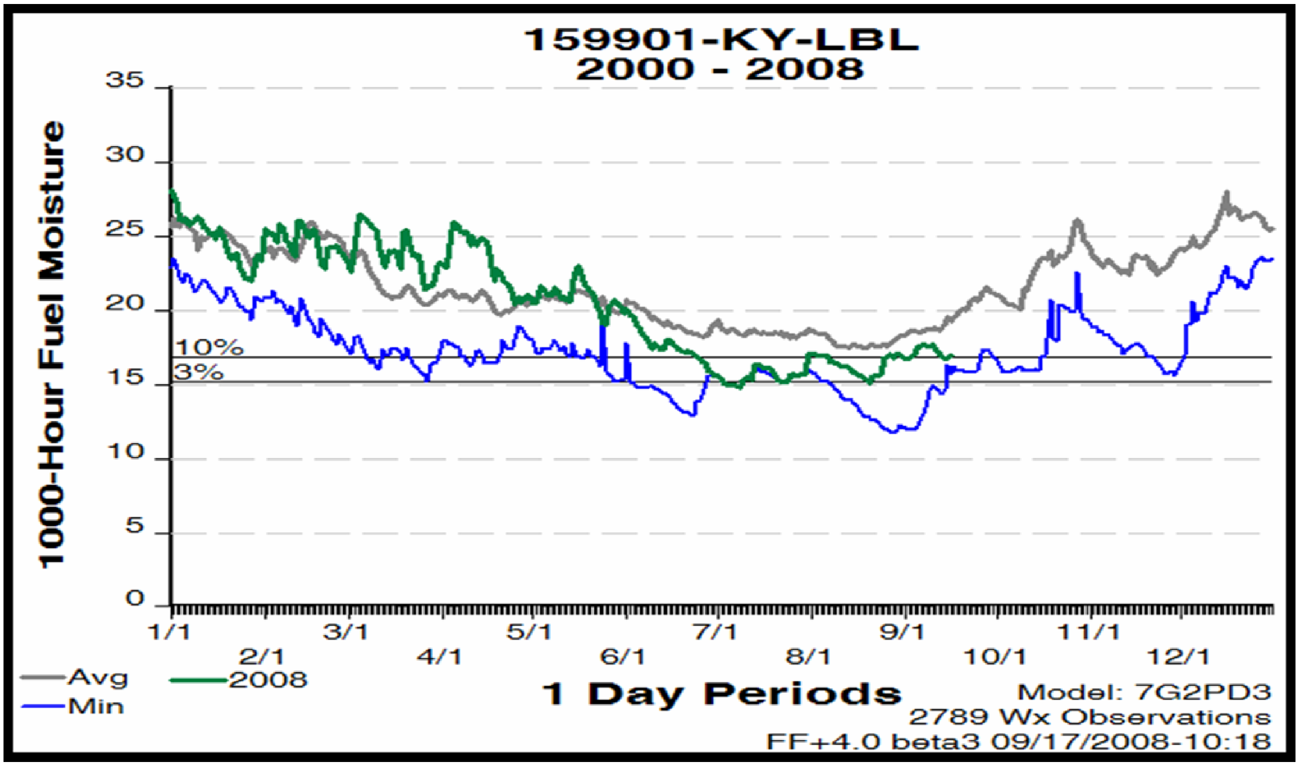
The Land between the Lakes National Recreation Area is located in southwestern Kentucky and is made up of approximatley 175,000 acres. The primary mission of this USDA Forest Service administered land is recreation and education. To support these missions the unit maintains an active forest management program. During the damage assessment completed for Hurricane Ike in Texas it was determined that the Land Between the Lakes National Recreation Area had received significant damage due to winds in excess of 70 MPH.

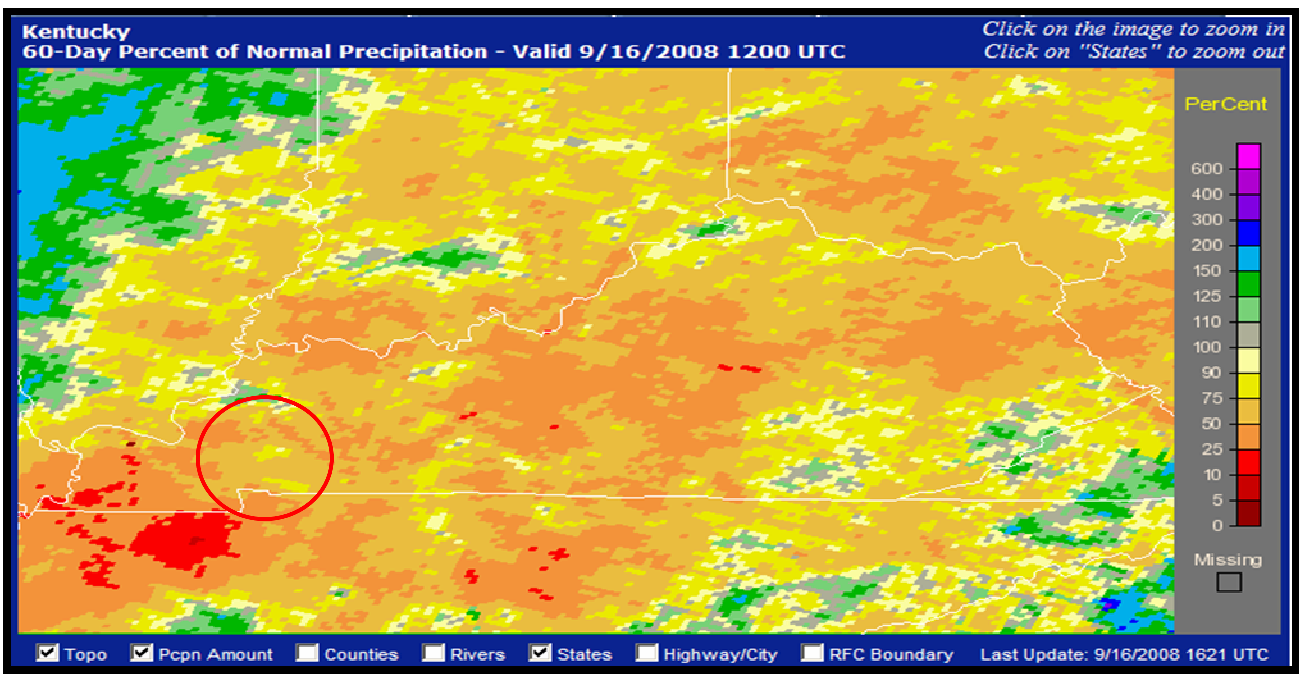
Current Fuel Conditions



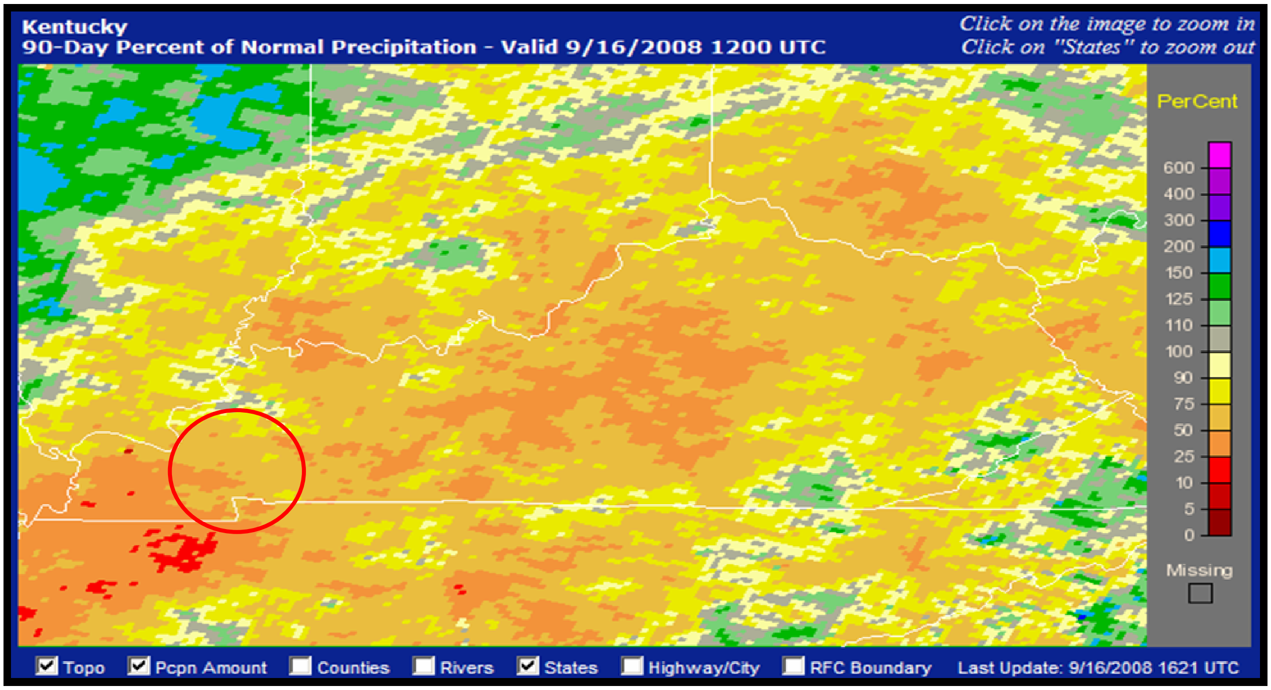
Fire danger at Land between the Lakes after the passage of tropical storm Ike is very high. ERC values are near the 90th percentile, however with the arrival of fall ERC values traditionally drop in this area as cold front passages producing rain become more frequent.

1000 hour fuel moisture values are also uncharacteristically low for this time of the year. Large fuels are currently near the 10th percentile. Only ten percent of the days from 2000 to 2008 have seen drier conditions in large dead fuels. These values should be near the low point of the year and will most likely begin to climb as days get shorter allowing for longer periods of high nighttime relative humidity recovery and as cold frontal passage produce rainfall.

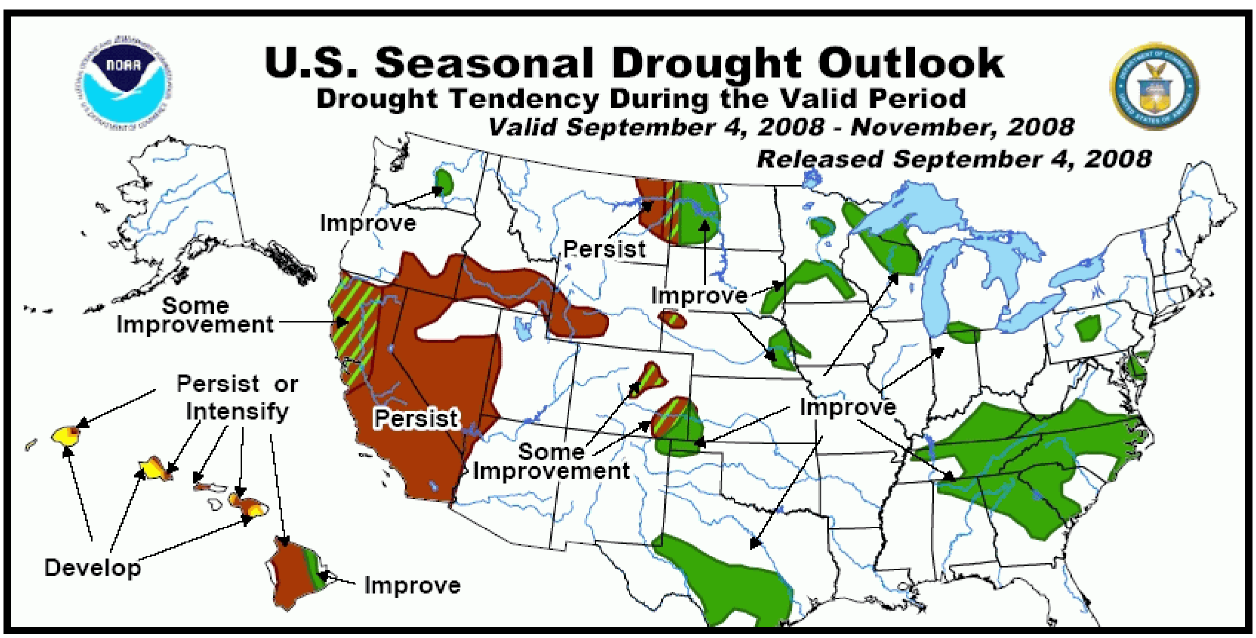




Precipitation deficits seem to be the primary driving force behind the increased fire danger. There are deficits at 30-60 and 90 days. The Land between the Lakes RAWS received no precipitation from the passage of Tropical storm Ike. The station did however receive significant winds.

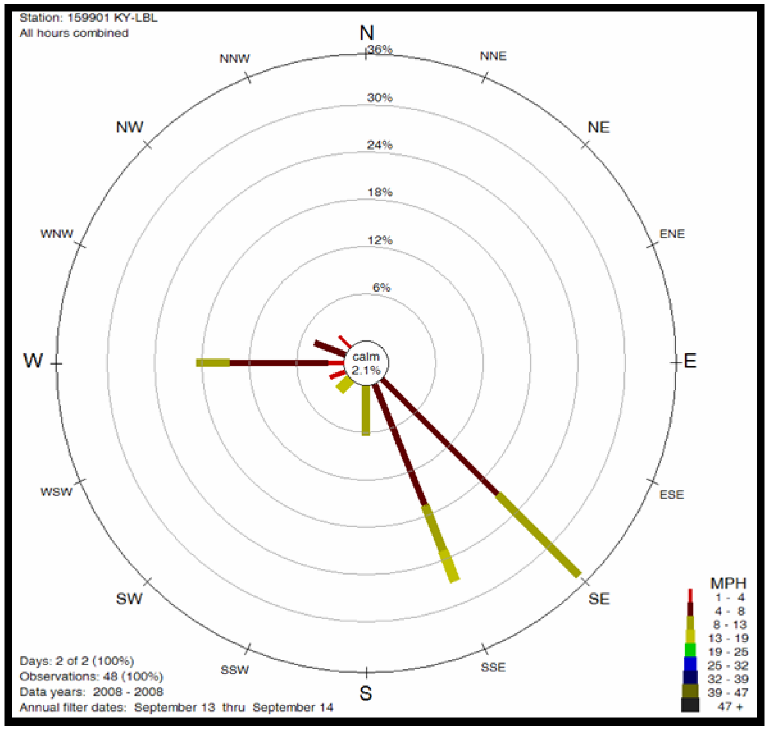


These precipitation deficits are forecast to improve through November as moisture begins to move into the eastern U.S. Fuel moisture values will also increase as longer nights allow for greater nighttime high humidity durations.



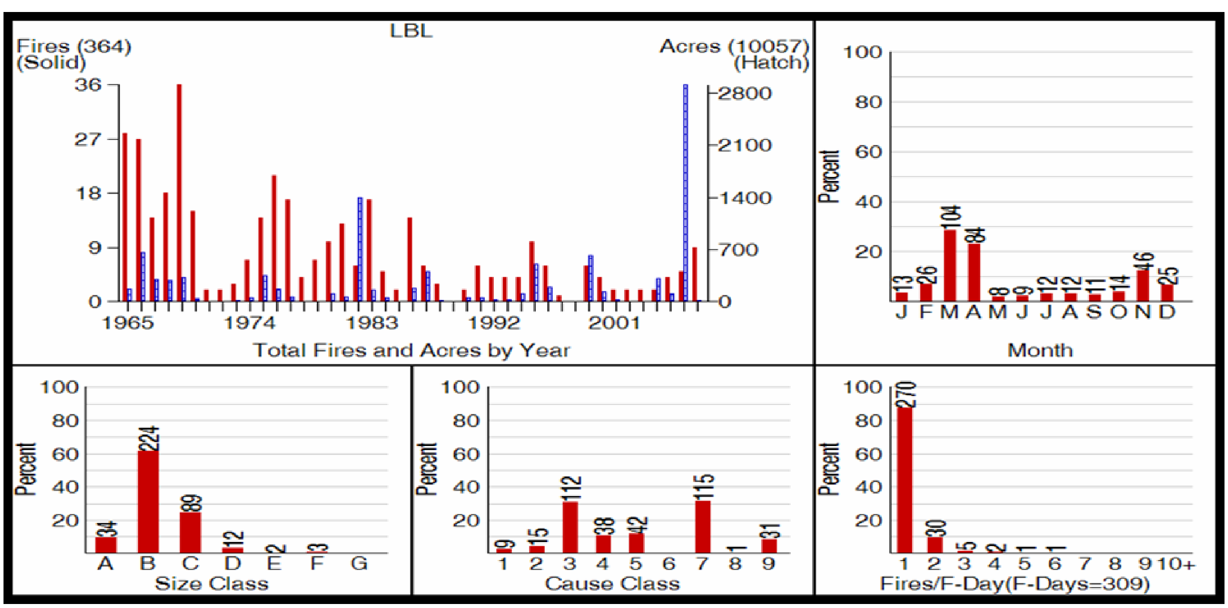
Effects of Ike

The damage at Land between the Lakes was caused by winds in the right front quadrant of the remnants of Hurricane Ike. For several hours the LBL RAWS site reported sustained 10 minute average winds in excess of 12 MPH with gusts up to 40 MPH. These winds caused damage to timber along the edges of lakes and in lower tree density areas such as campgrounds.



Fire Behavior Implications

Fire at LBL is not a common occurrence; there have been only 344 reported fires at the site from 1965 until 2007. Of these fires two were greater than 1000 acres during the spring of 2006 during a period of extended drought. The majority of fires occur at this site during the spring with the peak of the fire season being in March. There is also a small peak in fire activity in November after leaf drop. This fall peak may be early this year with many leaves already on the ground due to the winds from Ike.



In the post hurricane fuel bed rates of spread will not increase significantly. Timber types at this site are primarily mixed pine/ hardwood and pure hardwood. These vegetation types do not typically have rates of spread that would exceed the capabilities of initial attack forces under all but the most extreme conditions. Flame lengths and fireline intensity will increase somewhat but will still not exceed the capabilities of initial attack forces until fire danger is above the 97th percentile. The primary implications that this storm will have on fire suppression is in access issues and in mopup required. Large diameter hardwood stems on the ground will be difficult for tractor plow or engine crews to navigate through safely. During fire season as these heavy fuels dry and become available for active consumption mopup will become significantly more difficult. Smoke management will also become a concern as these heavy fuels begin to burn for long periods.

Summary

Although significant timber damage has occurred at the Land between the Lakes site, this should not have great implications to fire management. This is a low fire occurrence area comprised of a fuel bed which does not typically lend itself to extreme fire behavior. In the upcoming year as storm cleanup continues national fire danger indices should be closely monitored and as they approach significant fire business thresholds management actions such as camping/campfire restrictions should be considered. Safety concerns relating to access issues, snags, and increased intensities should be emphasized by incident commanders prior to committing forces to the fireline. Appropriate Management Response should be discussed with administrators prior to fire season, with fire use, and indirect fireline being considered to safely and effectively manage fire response in blow down areas.

APPENDIX C: Scott & Burgan Standard Fuel Models for Fire Behavior Prediction: Fuel Models Used in Hurricane Ike Wildland Fire Hazard Assessment

Introduction to the "40 fuel models"

The original 13 fire behavior fuel models are "for the severe period of the fire season when wildfires pose greater control problems..." (Anderson 1982). Those fuel models have worked well for predicting spread rate and intensity of active fires at peak of fire season in part because the associated dry conditions lead to a more uniform fuel complex, an important assumption of the underlying fire spread model (Rothermel 1972). However, they have deficiencies for other purposes, including prescribed fire, wildland fire use, simulating the effects of fuel treatments on potential fire behavior, and simulating transition to crown fire using crown fire initiation models. Widespread use of the Rothermel (1972) fire spread model and desire for more options in selecting a fuel model indicate the need for a new set of models to

- Improve the accuracy of fire behavior predictions outside of the severe period of the fire season, such as prescribed fire and fire use applications. For example, the original grass models 1 (short grass) and 3 (tall grass) are fully cured to represent the most severe part of the fire season. Applying those fuel models to situations in which the grass fuelbed is not fully cured (that is, outside the severe part of the fire season) leads to over-prediction.

- Increase the number of fuel models applicable in high-humidity areas. With the Rothermel spread model, the only way to accommodate fuel complexes that burn well at high humidity is through the moisture of extinction parameter. Only a few of the original 13 fuel models are appropriate for fuelbeds that burn well at relatively high dead fuel moistures.

- Increase the number of fuel models for forest litter and litter with grass or shrub understory. Predicted surface fire behavior drives crown fire models (Van Wagner 1977, Alexander 1988), so increased precision in surface fire intensity prediction will lead to increased precision in crown fire behavior prediction and hazard assessment.

- Increase the ability to simulate changes in fire behavior as a result of fuel treatment by offering more fuel model choices, especially in timber-dominated fuelbeds. This fuel model set does not attempt to directly simulate the effects of the wide variety of available fuel treatment options.

Characteristics

This new set of standard fire behavior fuel models is designed to stand alone; none of the original 13 fire behavior fuel models is repeated in the new set; the fuel model selection guide points to the new fuel models only. However, the original 13 fire behavior fuel models are still available; they are still called fire behavior fuel models 1-13.

In this new set, all fuel models with an herbaceous component are dynamic. In a dynamic fuel model, live herbaceous load is transferred to dead as a function of the live herbaceous moisture content. Although the new fuel model parameters can be input to a non-dynamic fire behavior processor, that approach does not produce the intended result. Using the dynamic fuel models in a non-dynamic fire behavior model would leave the live herbaceous load in the live category, regardless of moisture content. The grass models will therefore predict no (or very little) spread and intensity under any wind or moisture condition.

The change to dynamic fuel models is really a change in both the fire behavior processors and concurrently how fuel models for grass- or herbaceous-dominated fuelbeds are conceived. In this case, the desire for grass and herbaceous fuel models that could be used at various levels of curing precipitated the change in fire behavior processors. Fire behavior modeling systems must be modified to correctly use the new dynamic fuel models.

This Appendix contains an abbreviated version of the 40 Standard Fire Behavior Fuel Models limited to those fuel models used in this assessment.

GR3: Low Load, Very Coarse, Humid Climate Grass (Dynamic)

The primary carrier of fire in GR3 is continuous, coarse, humid-climate grass. Grass and herb fuel load is relatively light; fuelbed depth is about 2 feet. Shrubs are not present in significant quantity to affect fire behavior.

Fuel Model Code	Fuel Load (t/ac)					Fuel model Type	Fuel bed depth (ft)	Dead Fuel Extinction Moisture Content (%)
	1 hr	10 hr	100 hr	Live herb	Live wood			
GR3	.1	.4	0	1.5	0	Dynamic	2	30

GR5: Low Load, Humid Climate Grass (Dynamic)

The primary carrier of fire in GR5 is humid-climate grass. Load is greater than GR3 but depth is lower, about 1 to 2 feet.

Fuel Model Code	Fuel Load (t/ac)					Fuel model Type	Fuel bed depth (ft)	Dead Fuel Extinction Moisture Content (%)
	1 hr	10 hr	100 hr	Live herb	Live wood			
GR5	.4	.0	0	2.5	0	Dynamic	1.5	40

GS3: Moderate Load, Humid Climate Grass-Shrub (Dynamic)

The primary carrier of fire in GS3 is grass and shrubs combined. Moderate grass/shrub load, average grass/shrub depth less than 2 feet. Spread rate is high; flame length moderate. Moisture of extinction is high.

Fuel Model Code	Fuel Load (t/ac)					Fuel model Type	Fuel bed depth (ft)	Dead Fuel Extinction Moisture Content (%)
	1 hr	10 hr	100 hr	Live herb	Live wood			
GS3	.30	.25	0	1.45	1.25	Dynamic	1.8	40

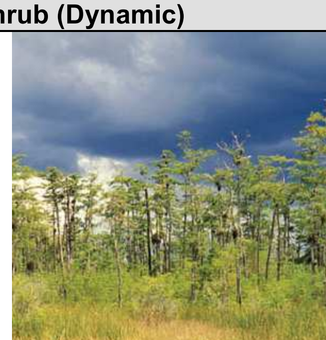
SH9: Very High Load, Humid Climate Shrub (Dynamic)

The primary carrier of fire in SH9 is woody shrubs and shrub litter. Dense, finely branched shrubs with significant fine dead fuel, about 4 to 6 feet tall; some herbaceous fuel may be present. Spread rate is high, flame length very high.

Fuel Model Code	Fuel Load (t/ac)					Fuel model Type	Fuel bed depth (ft)	Dead Fuel Extinction Moisture Content (%)
	1 hr	10 hr	100 hr	Live herb	Live wood			
SH9	4.5	2.45	0	1.55	7	Dynamic	4.4	40

TU3: Moderate Load, Humid Climate Timber-Grass-Shrub (Dynamic)

The primary carrier of fire in TU3 is moderate forest litter with grass and shrub components. Extinction moisture is high. Spread rate is high; flame length moderate.



Fuel Model Code	Fuel Load (t/ac)					Fuel model Type	Fuel bed depth (ft)	Dead Fuel Extinction Moisture Content (%)
	1 hr	10 hr	100 hr	Live herb	Live wood			
TU3	1.1	0.15	.25	.65	1.1	Dynamic	1.3	30

TL2: Low Load Broadleaf Litter

The primary carrier of fire in TL2 is broadleaf (hardwood) litter. Low load, compact broadleaf litter. Spread rate is very low; flame length very low.

Fuel Model Code	Fuel Load (t/ac)					Fuel model Type 1 hr	Fuel bed depth (ft) 10 hr	Dead Fuel Extinction Moisture Content (%) 100 hr
	1 hr	10 hr	100 hr	Live herb	Live wood			
TL2	1.4	2.3	2.2	0	0	N/A	.2	25

TL4: Small downed logs

The primary carrier of fire in TL4 is moderate load of fine litter and coarse fuels. Includes small diameter downed logs. Spread rate is low; flame length low.

Fuel Model Code	Fuel Load (t/ac)					Fuel model Type	Fuel bed depth (ft)	Dead Fuel Extinction Moisture Content (%)
	1 hr	10 hr	100 hr	Live herb	Live wood			
TL4	.5	1.5	4.2	0	0	N/A	.4	25

TL6: Moderate Load Broadleaf Litter

The primary carrier of fire in TL6 is moderate load broadleaf litter, less compact than TL2. Spread rate is moderate; flame length low.

Fuel Model Code	Fuel Load (t/ac)					Fuel model Type	Fuel bed depth (ft)	Dead Fuel Extinction Moisture Content (%)
	1 hr	10 hr	100 hr	Live herb	Live wood			
TL6	2.4	1.20	1.20	0	0	NA	.3	25

TL7: Large Downed Logs

The primary carrier of fire in TL7 is heavy load forest litter, includes larger diameter downed logs. Spread rate low; flame length low.

Fuel Model Code	Fuel Load (t/ac)					Fuel model Type	Fuel bed depth (ft)	Dead Fuel Extinction Moisture Content (%)
	1 hr	10 hr	100 hr	Live herb	Live wood			
TL7	.3	1.4	8.10	0	0	N/A	.4	25

TL9: Very High Load Broadleaf Litter

The primary carrier of fire in TL9 is very high load, fluffy broadleaf litter. TL9 can also be used to represent heavy needle-drape. Spread rate is moderate; flame length moderate.

Fuel Model Code	Fuel Load (t/ac)					Fuel model Type	Fuel bed depth (ft)	Dead Fuel Extinction Moisture Content (%)
	1 hr	10 hr	100 hr	Live herb	Live wood			
TL9	6.65	3.3	4.15	0	0	N/A	.6	35

SB1: Low Load Activity Fuel

The primary carrier of fire in SB1 is light dead and down activity fuel. Fine fuel load is 10 to 20 t/ac, weighted toward fuels 1 to 3 inches diameter class, depth is less than 1 foot. Spread rate is moderate; flame length low.

Fuel Model Code	Fuel Load (t/ac)					Fuel model Type	Fuel bed depth (ft)	Dead Fuel Extinction Moisture Content (%)
	1 hr	10 hr	100 hr	Live herb	Live wood			
SB1	1.5	3.0	11.0	0	0	N/A	1.0	25

SB2: Moderate Load Activity Fuel or Low Load Blowdown

The primary carrier of fire in SB2 is moderate dead and down activity fuel or light blowdown. Fine fuel load is 7 to 12 t/ac, evenly distributed across 0 to 0.25, 0.25 to 1, and 1 to 3 inch diameter classes, depth is about 1 foot. Blowdown is scattered, with many trees still standing. Spread rate is moderate; flame length moderate.

Fuel Model Code	Fuel Load (t/ac)					Fuel model Type	Fuel bed depth (ft)	Dead Fuel Extinction Moisture Content (%)
	1 hr	10 hr	100 hr	Live herb	Live wood			
SB2	4.5	4.2	4	0	0	N/A	1	25

SB3: High Load Activity Fuel or Moderate Load Blowdown

The primary carrier of fire in SB3 is heavy dead and down activity fuel or moderate blowdown. Fine fuel load is 7 to 12 t/ac, weighted toward 0 to 0.25 inch diameter class, depth is more than 1 foot. Blowdown is moderate, trees compacted to near the ground. Spread rate is high; flame length high.

Fuel Model Code	Fuel Load (t/ac)					Fuel model Type	Fuel bed depth (ft)	Dead Fuel Extinction Moisture Content (%)
	1 hr	10 hr	100 hr	Live herb	Live wood			
SB3	5.5	4.2	3	0	0	N/A	1.2	25

APPENDIX D: NEXUS Fire Behavior Outputs for Four Percentile Weather Classes

MODERATE

Vegetation Cover Types	Existing Vegetation Types	Pre-Fuel Model	Pre-Fire Behavior		Post-Hurricane			
					Moderate		Severe	
			FL	ROS	FL	ROS	FL	ROS
Coastal Marsh								
	Gulf Coast Salt Marsh	GR3	.7	1.4	3.4	11.9	3.4	11.9
	Sea Oats	GRS	.7	1.4	.7	1.4	.7	1.4
	Florida Salt Marsh	GR5	1.9	3.2	5.1	12.7	5.1	12.7
Prairie								
	Modified/Managed Grassland	GR3	.7	1.4	.7	1.4	.7	1.4
	Bluestem Prairie	GR3	.7	1.4	.7	1.4	.7	1.4
	Mesquite-Live Oak-Seacoast Bluestem	GR3	.7	1.4	.7	1.4	.7	1.4
	Mesquite-Ganjeno-Acacia	GR3	.7	1.4	.7	1.4	.7	1.4
	Bluestem-Sacahuista Prairie	GR3	.7	1.4	.7	1.4	.7	1.4
	Little Bluestem-Indiangrass-Texas Wintergrass	GR3	.7	1.4	.7	1.4	.7	1.4
WCP Pine Sandhill								
	Ruderal Forest	TL2	.4	.3	.4	.3	.4	.3
		TL6	1.1	1	1.1	1	1.1	1
	Recently Logged Timberland - Herbaceous	GR3	.7	1.4	.7	1.4	.7	1.4
	Recently Logged Timberland - Shrub	GS3	1.2	1.9	1.2	1.9	1.2	1.9
	Managed Tree Plantation	GR3	.7	1.4	1.5	1.5	4.1	5.6
	Post Oak-Blackjack Oak	TL2	.4	.3	.4	.3	.4	.3
		TL6	1.1	1	1.1	1	1.1	1
	Longleaf Pine-Scrub Oak	GR3	.7	1.4	1.5	1.5	4.1	5.6
		TL6	1.1	1	1.1	1	2.8	3.2
	Shortleaf Pine-Oak	SH9	9.1	11.6	9.1	11.6	9.1	11.6
	Loblolly Pine-Hardwood	TL6	1.1	1	1.1	1	2.8	3.2
		GR3	.7	1.4	2.8	3.2	4.1	5.6
	Live Oak	TL6	1.1	1	1.1	1	1.1	1
WCP Pine Savannah Wetland								
	Longleaf Pine-Slash Pine	TU3	3.1	4.9	2.8	3.2	4.1	5.6
		TL6	1.1	1	2.8	3.2	4.1	5.6
BLH								
	Great Plains Riparian	TL2	.4	.3	.6	.5	.6	.5
	Coastal Plain Swamp	TL2	.4	.3	.6	.5	1	.7
	Introduced Woody Wetlands and Riparian	TL2	.4	.3	.6	.5	1	.7
	Willow Oak-Water Oak-Diamondleaf Oak	TL2	.4	.3	2	1.6	1.5	1.5
	Sweetgum-Willow Oak	TL2	.4	.3	2	1.6	1.5	1.5

HIGH

Vegetation Cover Types	Existing Vegetation Types	Pre-Fuel Model	Pre-Fire Behavior		Post-Hurricane			
					Moderate		Severe	
			FL	ROS	FL	ROS	FL	ROS
Coastal Marsh								
	Gulf Coast Salt Marsh	GR3	1.8	5.5	4.8	23	4.8	23
	Sea Oats	GRS	1.8	5.5	1.8	5.5	1.8	5.5
	Florida Salt Marsh	GR5	3.6	8.5	7.3	26	7.3	26
Prairie								
	Modified/Managed Grassland	GR3	1.8	5.5	1.8	5.5	1.8	5.5
	Bluestem Prairie	GR3	1.8	5.5	1.8	5.5	1.8	5.5
	Mesquite-Live Oak-Seacoast Bluestem	GR3	1.8	5.5	1.8	5.5	1.8	5.5
	Mesquite-Ganjeno-Acacia	GR3	1.8	5.5	1.8	5.5	1.8	5.5
	Bluestem-Sacahuista Prairie	GR3	1.8	5.5	1.8	5.5	1.8	5.5
	Little Bluestem-Indiangrass-Texas Wintergrass	GR3	1.8	5.5	1.8	5.5	1.8	5.5
WCP Pine Sandhill								
	Ruderal Forest	TL2	.5	.5	.5	.5	.5	.5
		TL6	1.5	1.8	1.5	1.8	1.5	1.8
	Recently Logged Timberland - Herbaceous	GR3	1.8	5.5	1.8	5.5	1.8	5.5
	Recently Logged Timberland - Shrub	GS3	5.4	15.4	5.4	15.4	5.4	15.4
	Managed Tree Plantation	GR3	1.8	5.5	2.1	2.8	5.9	11.6
	Post Oak-Blackjack Oak	TL2	.5	.5	.5	.5	.5	.5
		TL6	1.5	1.8	1.5	1.8	1.5	1.8
	Longleaf Pine-Scrub Oak	GR3	1.8	5.5	2.1	2.8	5.9	11.6
		TL6	1.5	1.8	1.5	1.8	3.9	6.5
	Shortleaf Pine-Oak	SH9	13.4	25.8	13.4	25.8	13.4	25.8
	Loblolly Pine-Hardwood	TL6	1.5	1.8	1.5	1.8	3.9	6.5
		GR3	1.8	5.5	3.9	6.5	5.9	11.6
	Live Oak	TL6	1.5	1.8	1.5	1.8	1.5	1.8
WCP Pine Savannah Wetland								
	Longleaf Pine-Slash Pine	TU3	4.9	12	3.9	6.5	5.9	11.6
		TL6	1.5	1.8	3.9	6.5	5.9	11.6
BLH								
	Great Plains Riparian	TL2	.5	.5	.8	.8	.8	.8
	Coastal Plain Swamp	TL2	.5	.5	.8	.8	1.2	1.1
	Introduced Woody Wetlands and Riparian	TL2	.5	.5	.8	.8	1.2	1.1
	Willow Oak-Water Oak-Diamondleaf Oak	TL2	.5	.5	2.8	3	2.1	2.8
	Sweetgum-Willow Oak	TL2	.5	.5	2.8	3	2.1	2.8

VERY HIGH

Vegetation Cover Types	Existing Vegetation Types	Pre-Fuel Model	Pre-Fire Behavior		Post-Hurricane			
					Moderate		Severe	
			FL	ROS	FL	ROS	FL	ROS
Coastal Marsh								
	Gulf Coast Salt Marsh	GR3	2.3	7.9	5.3	28.3	5.3	28.3
	Sea Oats	GRS	2.3	7.9	2.3	7.9	2.3	7.9
	Florida Salt Marsh	GR5	4.2	10.9	8.2	32.5	8.2	32.5
Prairie								
	Modified/Managed Grassland	GR3	2.3	7.9	2.3	7.9	2.3	7.9
	Bluestem Prairie	GR3	2.3	7.9	2.3	7.9	2.3	7.9
	Mesquite-Live Oak-Seacoast Bluestem	GR3	2.3	7.9	2.3	7.9	2.3	7.9
	Mesquite-Ganjeno-Acacia	GR3	2.3	7.9	2.3	7.9	2.3	7.9
	Bluestem-Sacahuista Prairie	GR3	2.3	7.9	2.3	7.9	2.3	7.9
	Little Bluestem-Indiangrass-Texas Wintergrass	GR3	2.3	7.9	2.3	7.9	2.3	7.9
WCP Pine Sandhill								
	Ruderal Forest	TL2	.5	.6	.5	.6	.5	.6
		TL6	1.7	2.3	1.7	2.3	1.7	2.3
	Recently Logged Timberland - Herbaceous	GR3	2.3	7.9	2.3	7.9	2.3	7.9
	Recently Logged Timberland - Shrub	GS3	7.1	25.1	7.1	25.1	7.1	25.1
	Managed Tree Plantation	GR3	2.3	7.9	2.3	3.5	6.7	14.8
	Post Oak-Blackjack Oak	TL2	.5	.6	.5	.6	.5	.6
		TL6	1.7	2.3	1.7	2.3	1.7	2.3
	Longleaf Pine-Scrub Oak	GR3	2.3	7.9	2.3	3.5	6.7	14.8
		TL6	1.7	2.3	1.7	2.3	4.5	8.3
	Shortleaf Pine-Oak	SH9	15.7	36	15.7	36	15.7	36
	Loblolly Pine-Hardwood	TL6	1.7	2.3	1.7	2.3	4.5	8.3
		GR3	2.3	7.9	4.5	8.3	6.7	14.8
	Live Oak	TL6	1.7	2.3	1.7	2.3	1.7	2.3
WCP Pine Savannah Wetland								
	Longleaf Pine-Slash Pine	TU3	6.1	18	4.5	8.3	6.7	14.8
		TL6	1.7	2.3	4.5	8.3	6.7	14.8
BLH								
	Great Plains Riparian	TL2	.5	.6	.9	1	.9	1
	Coastal Plain Swamp	TL2	.5	.6	.9	1	1.4	1.3
	Introduced Woody Wetlands and Riparian Vegetation	TL2	.5	.6	.9	1	1.4	1.3
	Willow Oak-Water Oak-Diamondleaf Oak	TL2	.5	.6	3.1	3.7	2.3	3.5
	Sweetgum-Willow Oak	TL2	.5	.6	3.1	3.7	2.3	3.5

EXTREME

Vegetation Cover Types	Existing Vegetation Types	Pre-Fuel Model	Pre-Fire Behavior		Post-Hurricane			
					Moderate		Severe	
			FL	ROS	FL	ROS	FL	ROS
Coastal Marsh								
	Gulf Coast Salt Marsh	GR3	3.3	13.1	6.6	40.9	6.6	40.9
	Sea Oats	GRS	3.3	13.1	3.3	13.1	3.3	13.1
	Florida Salt Marsh	GR5	5.4	16.3	10.3	48	10.3	48
Prairie								
	Modified/Managed Grassland	GR3	3.3	13.1	3.3	13.1	3.3	13.1
	Bluestem Prairie	GR3	3.3	13.1	3.3	13.1	3.3	13.1
	Mesquite-Live Oak-Seacoast Bluestem	GR3	3.3	13.1	3.3	13.1	3.3	13.1
	Mesquite-Ganjeno-Acacia	GR3	3.3	13.1	3.3	13.1	3.3	13.1
	Bluestem-Sacahuista Prairie	GR3	3.3	13.1	3.3	13.1	3.3	13.1
	Little Bluestem-Indiangrass-Texas Wintergrass	GR3	3.3	13.1	3.3	13.1	3.3	13.1
WCP Pine Sandhill								
	Ruderal Forest	TL2	.7	.9	.7	.9	.7	.9
		TL6	2.3	3.7	2.3	3.7	2.3	3.7
	Recently Logged Timberland - Herbaceous	GR3	3.3	13.1	3.3	13.1	3.3	13.1
	Recently Logged Timberland - Shrub	GS3	9.2	39.3	9.2	39.3	9.2	39.3
	Managed Tree Plantation	GR3	3.3	13.1	3	5.5	9	24.6
	Post Oak-Blackjack Oak	TL2	.7	.9	.7	.9	2.3	3.7
		TL6	2.3	3.7	2.3	3.7	2.3	3.7
	Longleaf Pine-Scrub Oak	GR3	3.3	13.1	3	5.5	9	24.6
		TL6	2.3	3.7	2.3	3.7	6	13.7
	Shortleaf Pine-Oak	SH9	19.7	54	19.7	54	19.7	54
	Loblolly Pine-Hardwood	TL6	2.3	3.7	2.3	3.7	6	13.7
		GR3	3.3	13.1	6	13.7	9	24.6
	Live Oak	TL6	2.3	3.7	2.3	3.7	2.3	3.7
WCP Pine Savannah Wetland								
	Longleaf Pine-Slash Pine	TU3	7.9	28.6	6	13.7	9	24.6
		TL6	2.3	3.7	6	13.7	9	24.6
BLH								
	Great Plains Riparian	TL2	.7	.9	1.1	1.6	1.1	1.6
	Coastal Plain Swamp	TL2	.7	.9	1.1	1.6	1.7	1.9
	Introduced Woody Wetlands and Riparian Vegetation	TL2	.7	.9	1.1	1.6	1.7	1.9
	Willow Oak-Water Oak-Diamondleaf Oak	TL2	.7	.9	4.1	5.9	3	5.5
	Sweetgum-Willow Oak	TL2	.7	.9	4.1	5.9	3	5.5

APPENDIX E: Assessment Group Contact Information

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